

# **2010 BAKER FORUM**

## **EXPLORING THE MULTIPLE DIMENSIONS OF INNOVATION: IMPLICATIONS FOR POLYTECHNIC UNIVERSITIES**



**May 2 – 3, 2010**

### **THE BAKER FORUM PROCEEDINGS: 2002 TO 2010**

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**2010 BAKER FORUM**  
**EXPLORING THE MULTIPLE DIMENSIONS OF INNOVATION:**  
**IMPLICATIONS FOR POLYTECHNIC UNIVERSITIES**

**MISSION**

The Baker Forum was established by the Cal Poly President's Cabinet\* on the occasion of two decades of service to Cal Poly by President Warren J. Baker and his wife, Carly, to further the dialogue on critical public policy issues facing the nation and higher education. The forum gives particular attention to the special social and economic roles and responsibilities of polytechnic and science and technology universities.

The health and prosperity of humanity in the 21st century depend upon our ability to sustain and increase the pace of scientific and technical innovation. Polytechnic and science and technology universities must lead the way in ensuring that these innovations are applied broadly to serve the interests of society and in preparing new generations of innovators and problem-solvers.

The biennial Baker Forum provides an opportunity for polytechnic and science and technology university presidents and industry leaders to come together in an issue-focused, highly interactive setting designed to promote international dialogue, highlight issues of critical importance and stimulate creative responses.

Funding support from the President's Cabinet, friends of the university and John Wiley & Sons, Inc., is gratefully acknowledged.



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\*The Cal Poly President's Cabinet is a senior advisory group of business, industry, government and community leaders.

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**THE WILEY LIFETIME ACHIEVEMENT AWARD**

With the creation of the Baker Forum in 2002, John Wiley & Sons, Inc., generously established the Wiley Lifetime Achievement Award. This award recognizes extraordinary leadership and lasting contributions in American higher education and public life.

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## **PREFACE**

**Stephen J. Ciesinski, Chairman**  
**Cal Poly President's Cabinet**

Stephen Ciesinski, chairman of the Cal Poly President's Cabinet, convened the 2010 Baker Forum, "Exploring the Multiple Dimensions of Innovation: Implications for Polytechnic Universities." By way of preface, he shared a brief history of the cabinet's mission and the Baker Forum's inception and purpose. Ciesinski then introduced the forum's Keynote speaker and set the stage for Panel and Breakout sessions on the theme of innovation.

***"Leaders from education, industry and government discuss the multiple dimensions of innovation and their implications for polytechnic universities."***  
***– Stephen Ciesinski, Chairman, Cal Poly President's Cabinet***

"For three decades, Warren and Carly Baker have each year brought together the president's cabinet—a group of business, industry, government and community leaders—to discuss our state and nation's important challenges and to address innovative and practical ways in which Cal Poly can continue to help shape a better world for all of us. Let me say that the diverse members of the cabinet all share a passion for Cal Poly, and respect and admiration for the Bakers' inspiring and tireless leadership of our university for the past 31 years.

"In 1999 the Cal Poly President's Cabinet surprised the Bakers with an endowment that provides sustaining support for a public policy forum featuring leaders in education and industry. In presenting the endowment to the Bakers, our cabinet proposed that this yearly gathering be named the Baker Forum—to recognize not only their valued, longstanding contributions to Cal Poly, but also to help ensure the forum's success in attracting acknowledged experts from a range of disciplines and professions for significant exchanges of ideas.

"The purpose of the Baker Forum is to foster a conversation about the important role that polytechnic, science and technology universities play in our contemporary world, and to invite creative thinking about ways in which their intellectual and practical influence for the betterment of society can be strengthened. In keeping with the central theme of all of our forums, the 2010 Baker Forum features leaders from education, industry and government who will discuss the multiple dimensions of innovation and their implications for polytechnic universities.

"We begin this year's forum with a Keynote address by Dr. Walter Moos, vice president of the Biosciences Division at SRI International, who will share his experiences as an American innovator and his perspectives on the crucial part innovation plays in the development of new, lifesaving pharmaceuticals and on the critical place his industry occupies in the 21st century. Tomorrow, our forum participants will continue the dialogue and conversation Dr. Moos has begun and seek to identify ways in which Cal Poly can promote innovative models of thought and practice among its future graduates, further stimulate applied research responsive to the

needs of California's economy, and more broadly support the spirit and work of innovation across California and the nation.

***"Dr. Walter Moos, vice president of the Biosciences Division at SRI, shares his experiences concerning the crucial part innovation plays in the development of new, lifesaving pharmaceuticals." – Stephen Ciesinski***

"In introducing Dr. Moos, I would like to share with you his impressive background and his history of experience and leadership in pharmaceutical research and development. In 2005 Walter Moos joined SRI International, the prestigious nonprofit research institute based in Palo Alto, California, as vice president of its Biosciences Division. At SRI he leads a unique pharmaceutical team of more than 2,000 scientists who have the necessary resources to make breakthrough discoveries, develop important innovations, and deliver new and needed pharmaceuticals for human clinical trials.

"SRI Biosciences is an integrated R&D organization—like a university, it carries out basic research on disease mechanisms; like a biotech company, it discovers new drugs; and like a contract research organization, it provides pre-clinical services. Dr. Moos' experience in the pharmaceutical industry is extensive: From 1997 to 2004 he was chairman and CEO of Midocor, now called Migenix, and from 1991 through 1997 he was the vice president of R&D at Chiron, now Novartis. Working from 1982 to 1991 at Warner-Lambert, now Pfizer, he rose to the level of vice president of its Parke-Davis Pharmaceutical Research Division, becoming, I believe, the youngest vice president in that company's history.

"Dr. Moos has held adjunct faculty positions at the University of Michigan in Ann Arbor and has been an adjunct full professor at the University of California, San Francisco, since 1992 and at James Madison University since 2007. In addition, he has served on a variety of academic, government and industry advisory committees, has edited five books, founded multiple scientific journals, and has an approximate total of 150 published manuscripts and patents. Dr. Moos holds degrees from Harvard University and the University of California, Berkeley."

With this introduction, Ciesinski welcomed onto the stage the 2010 Baker Forum Keynote speaker, Walter Moos.





**THE DOLLARS AND SENSE  
OF PHARMACEUTICAL INNOVATION:  
SAVING LIVES THROUGH DRUG DISCOVERY**

**Walter H. Moos  
Vice President  
Biosciences Division  
SRI International**

In his Keynote address to the 2010 Baker Forum, Walter Moos, vice president of SRI International's Biosciences Division, described and analyzed the complex relationship between the economics of discovering, testing and providing new lifesaving medicines to the world's growing population, and the challenges of maintaining and increasing the spirit of innovation that makes crucial breakthroughs in pharmaceutical research possible.

***"California public universities provide a fertile atmosphere and staging ground for making very real advancements in any number of vital fields and endeavors."  
– Walter Moos, Vice President, Biosciences Division, SRI International***

Moos began his presentation by introducing the terms "pharmaceutical math" and "innovation for impact," two central aspects of pharmaceutical research whose interplay determines whether new and effective drugs are developed and reach those suffering from serious illnesses and diseases. Before outlining the crucial interrelation between economics—and other "mathematical aspects" of pharmaceutical production—and the process of timely scientific discovery, Moos prepared his audience with a cogent observation from an unlikely source, as a preface to an expression of gratitude.

"Because I'll be talking about health care, I have to start with a quote from a doctor. He may not be the doctor you might expect, but he was a 'doctor of life' and his name was Dr. Seuss, the author of *The Cat in the Hat* and many other wonderful and wise stories for children and adults. Dr. Seuss wrote many true words and it seems especially appropriate to begin my talk with this sharp insight from the good doctor:

"'Unless someone like you cares a whole awful lot, nothing is going to get better. It's not.'

"How true Dr. Seuss' words are, for real progress in pharmaceutical and medical research and as a general premise for improving both life and the formal education that enhances our lives. Fortunately for Cal Poly and its students and faculty, for 31 years there has been someone who 'cares a whole awful lot.' Those of us who received our education at California public universities know how important our state-supported university system is in providing a fertile atmosphere and staging ground for making very real advancements in any number of vital fields and endeavors. Let me say, 'Thank you, President Baker, for everything you've done that's made today better and that paves the way for a better future.'"

Moos' emphasis on preparing an enhanced future through "care-driven," innovative education and research next focused on another book, one that Moos described as prophetic of the current and waiting challenges facing innovators intent on improving the lives of the world's population.

***Accelerating change has drastically altered the way we view both the present and the future of corporations that deliver innovative technologies.***

"For those of you who have been around since 1970, you may remember *Future Shock*. At the time of its publication, Alvin Toffler's book was perhaps misunderstood, but he presented a central point that has come true with a vengeance—that the future would bring too much change in too short a period of time. In the '70s Toffler made many far-seeing predictions that have since proven correct, and he rightfully became well known as an inspired futurist. I want to especially note two of his very prescient forecasts that have a direct bearing on innovation and progress.

"First, Toffler suggested that the illiterate of the future would not be the person who couldn't read—that person was the illiterate of the past. The illiterate of the future would be the person who didn't know how to learn. I would expand Toffler's definition of illiteracy to include the person who does not know how 'to learn and do.' Of course, learning and doing are the twin hallmarks of a Cal Poly education and the basis for the success of the university's many thousands of graduates.

"Second, Toffler predicted that the next major cultural 'explosion' was going to have something to do with genetics and computers. Now, we are certainly going through that continuing explosion today and all of us are racing to keep pace with its revolutionary effects."

Moos suggested that accelerating change—in a span of time too brief to accommodate its new directions and ramifications—has drastically altered the way we view both the present and the future of corporations that deliver innovative technologies.

"Some of you may be familiar with the phrase 'creative destruction.' The term was presented in the 2001 book *Creative Destruction: Why Companies That Are Built To Last Underperform the Market—and How To Successfully Transform Them*, by Richard Foster and Sarah Caplan. The authors described a quickly changing corporate landscape and a shortened 'life span' for many large companies. In the early 1900s, big corporations might be expected to 'last forever,' or at least for a century. In recent years that expected lifetime has almost geometrically decreased—we now commonly talk about the death of corporations, including major corporations, within a dozen years of their inception."

The "explosion" of computer technology, Moos added, provides an apt analogy for the shortened lives of companies that once would have been expected to flourish for a century or more and span several human generations.

“You’ve all heard about Moore’s Law, which sets out the exponential rise in the power of computers, a law that in our economy is matched by a corresponding continued decrease in the cost of computers. You could say that we now have an ‘exponential economy’ in the midst of an ‘exponential technology explosion’ that drives and constantly alters or mutates our economy and culture. We’re all learning the hard truth of that very old saying, ‘Standing still is going backwards,’ and you could now alter that warning to read ‘exponentially backwards.’ If you’re just standing in place and watching as Toffler’s predicted changes accelerate in front of you, then you find yourself racing into the past.”

Our pressing need for innovation, for the discovery and creation of new practical answers in a rapidly transforming economic and technological global environment, is the key to our survival, Moos emphasized.

“It’s only appropriate that I begin with a dictionary definition. ‘Innovation’ is a noun and means ‘a new method, a new idea, a new derivation.’ For our purposes, I believe we need a sharper definition, one that announces the stark fact that today, and into the foreseeable future, innovation is our one path, the only path we have for surviving the creative destruction I’ve described, which is unfolding simultaneously across corporate, economic, technological and cultural environments.

“Experts who study the nature of innovation tell us that successful, true innovations have many different aspects but are based on creation, delivery and value to the customer. Innovations that change the technological and economic landscape have to reach the marketplace as a sustainable business model. A product or technique that is ‘a flash in the pan’ is not an innovation—a creative idea may spark an innovative idea, but creativity without a sound motive and practical goal with the means to make it a commercial reality doesn’t result in an innovation.”

And where, Moos asked his Baker Forum audience, are today’s important innovations taking place?

“Innovations are being created in both large and small companies as well as within the universities. The corporations developing, producing or marketing new products vary by size and profits and include, among very large corporations like Lockheed Martin and Raytheon that have made a real difference in our daily lives, other entities that at first glance might strike us as unlikely contributors of new advances in technology. The income of a large nonprofit like SRI, with \$350 million in revenues in 2008, pales in comparison to those of Johnson & Johnson or Wal-Mart, huge corporations that play important roles in providing society with breakthroughs in current research—including many products that flow from innovations discovered and developed at our universities.”

The list of apparently “unlikely” corporations that bring the public needed new technology includes the giant pharmaceutical companies, Moos said. He pointed out that “Big Pharma,” as the large drug companies are often negatively termed, is often perceived to wear the “black hat,”

but that in reality the big pharmaceuticals face major challenges and must operate under economic conditions that make their good work increasingly difficult.

“For those of us in the nonprofit world, it’s nice to wear the ‘white hat’ most of the time. But in fairness to the big pharmaceutical companies, the fact is that they are facing operating costs that are high and constantly rising, and that the time required to deliver an approved drug to the marketplace is steadily increasing. Their productivity levels are going down as their costs are going up—a situation I’ll approach in detail when I describe ‘pharmaceutical mathematics.’ Drug companies confront a whole host of challenges, including our society’s building belief that good health should be an entitlement and that we shouldn’t have to pay to ensure our physical well-being.

***“The mission statement set in place at SRI’s founding was a commitment to discovery and the application of scientific and technological innovations to further knowledge, commerce, prosperity and peace.” – Walter Moos***

“It is true that the growing public expectation that enhanced health care shouldn’t turn solely on the profit motive does present an opportunity for nonprofit organizations [NPOs] to make significant headway in advancing public health, because we operate in certain areas that for-profit organizations [FPOs] aren’t designed to occupy and where they can’t effectively compete.”

The areas where NPOs are well equipped to make important contributions often involve a confrontation with global challenges that are critical and pressing but not necessarily “market-oriented.”

“Do you realize,” Moos asked his audience, “that tuberculosis infects one in three people in the world today? We’re talking about more than 2 billion people, most of them poor, who are infected with TB. This widespread and spreading, very serious disease is a prime example of a health-care challenge that SRI and other nonprofits, including universities and their research programs, can effectively engage.”

The strengths of nonprofit organizations and universities in discovering needed solutions to grave problems that exist outside the usual dynamics of the marketplace, Moos said, are based on what he calls “a community of innovation.”

“When I speak of a community of innovation, I am not referring to research for research’s sake, but research geared toward an innovative outcome that has a commercial focus. SRI itself was founded as the Stanford Research Institute in 1946 by nearby Stanford University, and today has about 2,000 staff members working at 20 sites around the world, including one not far from here in San Luis Obispo. Total revenues have grown to nearly \$500 million, and in health care we have created a pipeline of new drugs that are saving lives every day.

“The founding mission of nonprofits often guides those NPOs forever. The very noble mission statement set in place at SRI’s founding was a commitment to discovery and the application of scientific and technological innovations to further knowledge, commerce, prosperity and peace—a credo that today is still very much alive at SRI. In fact, we all carry that mission statement on a card that we keep in our pocket, to remind ourselves of our purpose and our goals.”

SRI’s community of innovation, Moos underlined, is the key to its longevity and success.

“We focus not just on ‘interesting’ problems but on ‘important’ problems. Sometimes people imagine that ‘interesting’ is enough, but in today’s rapidly changing world important problems are the prime target. At SRI we know that in finding solutions to complex challenges we cannot depend on a few brilliant researchers working on their own toward elusive breakthroughs. A team is needed, made up of people from many disciplines—I would say that the greatest excitement of discovery and implementation occurs when people from many different academic and professional backgrounds work together to deliver important, practical solutions that remedy pressing human needs.”

Before focusing in detail on biotechnology and pharmaceuticals, Moos quickly noted some of SRI’s important, non-medical inventions that exemplify its many pursuits and are part of SRI’s “legacy” of innovations that have had a profound effect on how we both work and spend our leisure time.

“The computer mouse was developed at SRI, and the standards for high-definition television were invented at the Sarnoff Corporation, one of SRI’s subsidiaries. The Emmy Award has been won several times by SRI. The Emmy statuette itself may have originated from a sketch by the wife of one of the engineers involved in the original breakthroughs in television technology. Inventions from SRI, such as innovations that made ultrasound imaging a practical procedure, have of course made a crucial impact on medical technology and have ‘spun off’ billion-dollar corporations like Intuitive Surgical, which is a robotic surgery company.”

Once again, Moos referenced Toffler’s *Future Shock*, exponential change, creative destruction and the saving path of innovation as he described the complexities of “pharma math” and the role nonprofit organizations and universities have to play in key medical research—research based on a “learning and doing” strategy within communities of innovation. Moos warned his audience that the challenges were somber and pressing.

“I want to make certain that everyone understands the critical relationship between improved health care and the development of new medicines for the treatment of disease. As I’m speaking to you today, hundreds to thousands of people will die from cancer, an unacceptable situation that demands a solution and that brings us to a subject that I introduced at the beginning of my talk: ‘pharma math.’”

Searching for and finding cures and treatments for serious diseases is a “high-risk, high-payoff

game,” Moos said, a challenge that involves not only great amounts of money but, more importantly, vast numbers of human lives: Each year in the United States there are almost 2 million deaths—four out of five the result of disease, and 75 percent of those deaths caused by one or more of the 12 most common fatal diseases.

***The average life expectancy in the United States has increased 60 percent over one century. Modern pharmaceuticals are a significant factor in extending longevity.***

The average life expectancy in the United States has increased dramatically over the last 100 years—in 1910 the life expectancy was 50 years and is now 80 years, a life-span increase of 60 percent over one century. Modern pharmaceuticals, Moos said, are a significant factor in extending longevity.

“It has been estimated that 40 percent of the increase in life expectancy is the result of drugs that have made it to the market. To clearly gauge the tremendous impact of pharmaceuticals, we need to understand that drugs that fight or cure disease have added 12 years of life for every American, and Americans now number 300 million. We can calculate that modern pharmaceuticals have added over 3 billion years of life to the current U.S. population, which is a truly staggering figure.”

Unfortunately, Moos continued, developing an effective drug to target a specific disease is a very slow and expensive process.

“On average, it takes 10 to 20 years to move from the breakthrough idea to an Investigational New Drug Application [IND] with the Food and Drug Administration [FDA] to start human trials, and then to a New Drug Application [NDA] that must be approved before the new drug can be sold to distributors and marketed to the public. And there are usually many failures along the way to finally delivering a safe, effective drug to the people who need it. In the long effort to discover and develop a successful drug, tens of thousands—sometimes millions—of ‘drug candidates’ fall away and at the end of the work- and cost-intensive journey one single drug is the result.

“The price of developing one drug to the stage of human testing is now in excess of half a billion dollars. And research and development costs are not static but constantly rising. Today it costs 10 times more to place a drug on the market than it did in the 1970s.

“The latest estimate from the Eli Lilly Company is \$1.8 billion for the 10 to 20 years of work required for a drug to reach the public. Added to the burden of skyrocketing costs is the fact that the pharmaceutical ‘success rate’ is going down. You might think that vastly increased spending would have an opposite result, but in 2009 only 20 new drugs were approved by the FDA for sale, compared to 50 in 1996.”

A widely held public assumption about this trend toward fewer approved drugs, Moos said, is



that pharmaceutical companies are “raking in” profits and not reinvesting in research and development, a conclusion that is incorrect.

“The reinvestment of net sales in R&D is higher than in most other companies—13 percent for pharmaceuticals and medicines, versus the ‘all-company’ average of 3.5 percent. Surprisingly, reinvestment by computer and electronics firms ranks a distant second to the drug industry. This year, pharmaceutical and biotechnology companies will spend a total of \$65 billion on research and development.”

Adding to the rising cost of producing new drugs is the relative decline in R&D funding from the National Institutes of Health [NIH].

***“An analysis of the economic impact of NIH-funded research from 1970 to 2000 found that the ‘dollars-and-cents profit,’ in terms of saved, improved and lengthened lives, was close to \$100 trillion.” – Walter Moos***

“In 1980, about the time President Baker joined Cal Poly, R&D funding from the NIH exceeded the research and development expenditures of the total pharmaceutical industry. Today, the money that the NIH spends on R&D amounts to less than half of what the pharmaceutical companies are investing in discovering and developing new drugs.”

The present situation is not good, Moos emphasized, and means that in the future fewer lives are going to be saved.

“Francis Collins, the new director of the NIH and one of the leaders of the original human-genome sequencing effort, recently completed an analysis of the economic impact of NIH-funded research from 1970 to 2000. The study found that the ‘dollars-and-cents profit,’ in terms of saved and improved and lengthened lives, was close to \$100 trillion, a wonderful success. And yet the NIH’s budget—the money it receives from our government—is declining, which is an unfortunate situation, whether measured in dollars or lives.”

Despite the long span of time and the exploding costs involved in developing a new drug, pharmaceutical and financial “miracles” do occur.

“Occasionally, a billion-dollar drug like Lipitor appears. Lipitor’s sales have reached \$12 billion to \$14 billion a year, although its patent is expiring and profits will decrease quite rapidly. For a moment, let’s examine how financial profits are shared when a new pharmaceutical makes it to market and becomes a billion-dollar drug. If you’re one of the innovators you might receive a royalty—it’s not unusual for the discovering entity to receive a 5-percent royalty on a successful drug. A billion-dollar product would return a royalty of about \$50 million per year, and it’s not unusual to have 10 years of market exclusivity. Obviously, large amounts of money are being earned by the researchers and organizations who invented the drug—and by the investors who supported the innovation. The chance of a large financial return is the reason why people

continue to invest in pharmaceutical research.

“Now, given the large profits successful drugs bring, you could conclude that drug prices are very high, and that’s what the media would like you to believe. However, the truth is that the price of drugs accounts for only 10 cents of every health-care dollar spent. It is true—because of the way the marketplace works—that the individual customer who requires a given drug pays a higher out-of-pocket percentage of the cost. And the consumer who buys a drug is also paying for the process of drug development, approval and delivery. But the central point remains that pharmaceuticals are a very good bargain.”

***“Last year we reached 50 million compounds in the Chemical Abstracts registry, and the number of compounds produced is rapidly increasing.”***  
***– Walter Moos***

Can more new, breakthrough drugs be developed more quickly, Moos asked, given the present economics and regulation of our drug discovery and delivery system?

“I think that we’ve only scratched the surface in finding and marketing breakthrough pharmaceuticals and there’s very much more that can be done. The FDA, in all of its years of operation, has approved only a few more than 1,200 drugs. That is not a large number, when you remember that the pharmaceutical industry has been federally regulated for about a century.”

The low total number of approved drugs, Moos explained, reflects the slowness of the old procedures of drug discovery and development.

“When I entered the industry in the early 1980s, a really, really good medicinal chemist working on new drugs would make one compound a week. Most of those compounds would be inactive, as I noted before in describing the vast numbers of failed ‘drug candidates’ that never reach testing, approval or customers. That was before combinatorial methods were introduced and new compounds were developed comprising great numbers of small beads or particles, each containing its own compound: A chemist can now create thousands or even millions of compounds in a single experiment.”

Although there are 25,000 human genes and their interplay within the human body is vast and complex, the problem of developing new medicines that target specific diseases is getting easier, Moos said, because of the “explosion” in the invention of new chemical compounds.

“Last year we reached 50 million compounds in the Chemical Abstracts registry, and the number of compounds produced is rapidly increasing. We might ask if at some future date we will have created all of the drugs humanity needs and the work of medical chemists will reach a successful end. How many different drugs are possible to invent that can be placed in a pill you can swallow each morning or evening?



“Theoretically, scientists could make an almost infinite number of possible drugs, a number that has been calculated at 10 to the 60th power—a number equal to all of the particles thought to exist in the universe. So, in theory, there will always be another needed drug waiting to be discovered, to cure a disease that today is incurable and new diseases that will suddenly and inevitably appear.”

After analyzing the aspects of pharmaceutical math, Moos next addressed our immediate, everyday need for effective new drugs that combat diseases and ailments that affect American and world society.

“Let’s say that, unfortunately, one of us here today is diagnosed with cancer and that today our researchers have just discovered a cure for that cancer. The sad truth is that the patient will die before that lifesaving drug reaches the market. Federal regulations, complications and delays in testing and approval, the very real concern that a new, promising drug might hurt someone—these are some of the main factors that slow the arrival of a breakthrough pharmaceutical. And yet the salient point, especially for the person who needs a wonder drug immediately, is that our process takes too long to develop and deliver crucial drugs and that this slowness is morally unacceptable.”

Again, Moos underlined the importance of “innovation for impact,” describing the encouraging, positive social environment in which he and other NPO scientists in pharmaceutical research operate, and noting the important role nonprofits can play in delivering badly needed drugs to patients.

“When I speak about ‘impact,’ I could also substitute the phrase, ‘Why I make drugs for a living.’ In the ’60s and ’70s, at a cocktail party, when someone asked your profession and you answered, “I make drugs,” the response was usually one of surprise and interest. Producing pharmaceuticals to improve the nation’s and world’s health was a ‘hot topic.’ These days developing and marketing drugs sometimes has a less positive social connotation—partly because of the public suspicion of Big Pharma—but the reason I and others in the industry do our work remains unchanged. I want now to play a brief recording, a quote from one of my colleagues, which explains why we work in pharmaceuticals.”

**Recorded Voice:** “So I talk to my friends in other fields, and I ask them, ‘What did you do last year?’ and some people say, ‘You know, I bought a company,’ or ‘I closed an SEC transaction.’ And when they ask me what I’ve been doing, I say, ‘Well, you know, I delivered a drug to market that’s going to save 2 million people a year and most of them are children under the age of five,’ and everyone goes, ‘Wow!’”

“My friend’s proud declaration,” Moos said, “is an excellent example of what the nonprofit world can accomplish. Nonprofits are not so tied to Wall Street and the financial markets—we’re in the enviable position of ‘Doing well by doing good,’ as the old saying goes. We can measure our success in terms of lives saved, and there are many, many lives still to be saved. For example,

every 30 seconds a child dies of malaria. The large numbers of people suffering and dying from dread diseases are staggering, as are the large numbers of lives that can be saved by the invention and distribution of successful drugs.

“Our desire and responsibility to keep working at what we do is increased by the fact that there are people who make an immoral profit from those who suffer: For example, 4,000 children die every year because they are given counterfeit malaria medication. And the parents of children killed or hurt by false drugs work over 3 million hours to pay for their children’s ineffective or harmful medication. Adults who are making a few pennies a week buy drugs to save the lives of their children, and the children are dying.”

For a long period, Moos acknowledged, the big pharmaceutical companies did not engage widespread infectious diseases that affect the poor, although in recent years large companies have improved their response.

“Big Pharma clearly was wearing the black hat for a while. From 1975 to 2000, only 1 percent of R&D money at large companies was focused on neglected diseases like malaria. Fortunately, over the last decade, they have been more active in working to develop drugs to aid the world’s underprivileged. Everyone hopes that the large pharmaceutical companies will continue to spend more money on this front, and that our government will continue to set policies that provide incentives for this work.”

Although nonprofits are less driven by the profit motive, Moos said, they are also very concerned with the economics of drug development and also must make money from the pharmaceuticals they discover.

“Nonprofit organizations don’t have investors to appeal to for added funding if a loss is incurred, and unlike the universities there is no income from student tuition fees. Often, nonprofits operate without an endowment. We at SRI and other NPOs have to make a profit, although we don’t need to show double-digit growth every year, as is often the case in the commercial world. I’m proud to say that SRI was one of the original groups to do work on anti-malarials. In association with the U.S. Army we put on the market a drug called halofantrine, which has saved millions of lives and is still in use in some locations in Africa, even though it’s an ‘old drug’ by now.”

The nonprofits’ efforts to cure infectious diseases are matched, Moos stressed, by the NPOs’ role in the worldwide fight against cancer.

“The World Health Organization has announced that this year cancer will become the No. 1 killer in the world. Again, nonprofits are coming to the rescue. A team effort comprising SRI; Southern Research in Birmingham, Alabama; and Memorial Sloan Kettering Cancer Center in New York City licensed a drug called Folutyn to the Colorado biotech company Allos, which gained FDA approval last September. Folutyn treats a very serious form of lymphoma. This new cancer drug should benefit 5,000 to 6,000 patients a year and represents a significant advance in

the fight against lymphoma. Folutyn could not have been successfully developed without the combined work of all the institutions and researchers that formed our group. News of the new drug was first published by SRI in 1993—in 2009, 16 years later, Folutyn was approved for the market, the result of the coordinated work of four organizations.”

Society’s need for pharmaceuticals will change, Moos said, as breakthrough drugs cure or effectively treat today’s common illnesses and the focus returns to “old diseases” that have re-emerged on a wide scale.

***“The 1918 Spanish flu killed 500,000 people in the United States and an estimated 50 million worldwide, spreading as far as the Arctic and isolated South Pacific islands.” – Walter Moos***

“For example, if we can develop a drug that can delay the onset of Alzheimer’s by five or 10 years, we will have effectively found a cure, because most elderly patients susceptible to the disease will ultimately die of another ailment. There have been massive improvements in preventing deaths from cardiovascular conditions, from heart and cerebrovascular diseases. But some of the old diseases and their variants are now posing new threats and include very serious communicable diseases, like swine flu, which pose the potential danger of pandemics.”

The long fight against infectious diseases will likely never end, Moos cautioned, despite even the most revolutionary advances in pharmaceuticals.

“We all need to remember that the certain, ‘reasoned’ statements any of us makes today may not prove true over time. In 1960 a Nobel Prize winner said that the future of infectious disease research would be ‘very boring.’ He had seen the widespread effectiveness of polio vaccination and other vaccines, and the introduction of the quinolones, wonder drugs that ultimately led to today’s on-the-market drugs like Cipro, which is used against anthrax and a number of other serious infections. The prize-winning scientist believed that the fight against the ‘old killers’ was over, but his words now sound uncomfortably close to those spoken in 1899 by the head of the U.S. Patent Office, who submitted his resignation to President McKinley by saying, ‘We’ve invented everything we’re ever going to invent. You may as well close this down.’

“Obviously, innovations continued to be made, just as infectious diseases were not a thing of the past, as the 1960s and ’70s and succeeding decades proved—there was Lassa fever, Ebola, Legionnaire’s Disease, hepatitis C virus, and of course HIV/AIDS, as well as West Nile virus, mad cow, Hantavirus, SARS, and anthrax microbes sealed in envelopes and sent by mail. We now worry about bioterrorism, and about pandemics like swine flu and bird flu, as well as dangerous bacteria that have become resistant to once-effective drugs. Unfortunately, our world and the world of medicine and pharmaceuticals have proven far from boring.”

Swine and bird flus, Moos underlined, pose daunting threats to world health and a monumental challenge to those professionals who would be in the forefront of combating a public health

disaster of the first magnitude.

“For context, let me remind you that the 1918 Spanish flu killed 500,000 people in the United States (and an estimated 50 million worldwide, spreading as far as the Arctic and isolated South Pacific islands). During World War II, 400,000 American servicemen and servicewomen were lost. The Spanish flu claimed 100,000 more American lives than the war in Europe and the Pacific.

“Our best estimates indicate that 80 million people in 2009 were infected with swine flu, a number that obviously puts swine flu in the category of a virus pandemic. A ‘mere’ \$700 billion was spent in combating the outbreak, in vaccinations and in treating those who were infected.

“If bird flu—H5N1—should begin to widely spread from person to person, the global economic impact could be \$3 trillion, but no amount of money could reclaim the millions of lost lives. How many people might die in a virulent bird-flu pandemic, for which at present we’re very ill prepared? The total number of worldwide deaths would probably equal the present combined populations of the American West Coast: California, Oregon, Washington and Alaska.”

What ramifications and challenges does the specter of such a frightening public-health danger—and other future medical crises, as well as complex revolutions in culture and economics—hold for American higher education, Moos asked, and for Cal Poly in particular?

“No one knows for certain what world we’ll confront tomorrow, because we’re entering the unknown, in public health and pharmaceuticals as well as in every other aspect of scientific, technological and economic endeavor, as we continue to encounter Toffler’s predicted era of accelerating time and change. You often hear that the studies today’s university students are pursuing will prove largely irrelevant for the jobs they will hold in 10 or 20 years, because technology is evolving so fast. I do think that Cal Poly, more than almost any other institution that I can think of, is especially well positioned to meet the future, thanks to its learn-by-doing concept of education, which fits Toffler’s description of the literacy of the future.

“At Cal Poly you have in place what I’ve called a community of innovation, with your partnerships with industry that promote team discovery, your emphasis on cross-disciplinary cooperation and joint projects, and your strong ethic of environmental responsibility. Your colleges of engineering, agriculture, architecture and environmental design, math and science, business, and liberal arts can encourage and support students and professors working together on important problems to achieve real improvements for tomorrow’s even more complex world.”

Moos expanded on the practical, economic complications presented by future shock and an uncertain age of creative destruction, stressing the need for the right atmosphere for innovation and further highlighting “concepts that are also the mission and strategic plan at Cal Poly, where ‘learn by doing’ is the governing credo for education and the right preparation for flexibility and adaptation as technological and cultural changes accelerate.

“The average lifetime of Standard & Poor’s 500 companies is going down dramatically, and today in the pharmaceutical industry developing a successful drug and delivering it to market require the concerted efforts of more than three different companies. Today’s university students can expect to hold at least 10 different jobs before they reach the age of 40.”

How can universities and nonprofits, and their students and employees, compete in Toffler’s new, constantly and swiftly evolving world? Moos asked.

“It is reassuring that both universities and nonprofit organizations have been much more stable than companies operating exclusively in the commercial world. At SRI I am often amazed—given the age of explosive change that we live in—that I work alongside so many people who have been in the same job for more than 30 years. Maintaining an NPO—or a cutting-edge polytechnic university—requires discipline, the setting of a careful, well-considered plan of present and future action that is not a random walk through science and technology and remains more of a science than an art. The most important assets for any organization are not only the people that you work with but also the way those people work and approach new challenges.

“I want now to list the five essentials for innovation that were presented in the recent book *Innovation: The Five Disciplines for Creating What Customers Want*, coauthored by Curtis R. Carlson, our CEO at SRI, and chosen by *Business Week* as one of the Top Ten Books of the Year. This list outlines the critical factors that are necessary for an organization to move through the innovation process to bring a new idea and product to the public marketplace:

- Important customer and market needs
- High value creation
- Innovative champion
- Innovation team
- Organizational alignment

“Our branding at SRI is that in discovering new drugs we move from idea to IND [Investigational New Drug], from basic ideas all the way through the research and development phase to the start of human clinical trials. We begin with the five disciplines of innovation, carry out research and development, and usually roughly break even, or show a modest profit by providing services to government and industry. And, occasionally, we have a real success, when an important drug reaches the market. We are currently receiving royalties from Folutyn, the newly approved lymphoma drug, and from a few other pharmaceuticals that we invented and that were approved by the FDA. Our constant credo is ‘Never miss an opportunity to improve, and remember that you can always do better and more.’ This is a self-funding business model, the kind in place at most colleges and universities.

“Our model at SRI is by no means perfect but it has been very successful when you consider the many ‘hand-offs’ and the interdisciplinary teamwork that have to take place to deliver an approved drug to consumers. Our community-of-innovation process involves biology, chemistry, clinical toxicology, engineering, project management and other necessary areas of expertise

coordinated toward one goal. The complexity and difficulty of our task requires us to find a niche—that's what a small player like a nonprofit or a single research lab directed by a professor must do. At SRI, our focus has been to bridge the so-called 'Valley of Death,' to move projects from basic research to a promising 'product candidate' and then hand off our finished work to someone else to take it to market."

***"It requires \$881 million to deliver a drug to market, and over \$650 million of that \$881 million accounts for the drug candidates that failed." – Walter Moos***

Moos emphasized that companies and nonprofits that discover new pharmaceuticals have to be "very engaged and balanced," because most of the ideas for better and different drugs will fail.

"There are many people working in our industry who will never succeed in getting a single drug to the public. The numbers show—and these are not current numbers but are slightly dated—that it requires \$881 million to deliver a drug to market, and that over \$650 million of that \$881 million accounts for the drug candidates that failed. So what is SRI's 'value proposition'? We have developed a strategy for tackling the inherently risky early stages in producing a new drug by concentrating on the stages of basic research, biology, chemistry and pre-clinical work, leaving the later development stages to others. By using this approach we've been able to eliminate \$500 million in risk, which we believe is a very good value proposition and in line with our acknowledgement that getting effective drugs to market is a team effort."

***"What will happen if a pandemic crisis occurs during our lifetimes and how will the makers of drugs react?" – Walter Moos***

Especially for a nonprofit, Moos said, there is always another central consideration: Beyond the purely economic looms the human factor, the well-being of present and future populations, which always has to be of prime importance in making decisions concerning which direction research and investment should take.

The problems decision-makers face can be immense, with 7 billion people on the planet and each individual with a different genome. However, Moos pointed out, "These are important problems, not just interesting ones, and the work of a community of innovators, both within and outside one's organization, must be decisive in targeting and solving crucial health challenges.

"Let me return once more to the subject of a massive, worldwide health threat. What will happen if a pandemic crisis occurs during our lifetimes and how will the makers of drugs react?

"In a sudden global health emergency none of us can wait 10 or 20 years for a drug to be developed, approved and delivered to us and other people at risk. A catastrophic outbreak could decimate world population. There are times when medical and pharmaceutical professionals responsible for dealing with an immense crisis must be utterly, immediately practical and ask,



‘What drugs do we already have on the shelf? What prescription drugs do we have to choose from and will they work, perhaps unexpectedly, against this new virus or bacterium?’

“Sometimes ‘old drugs’ designed for another purpose can be lifesavers in confronting new crises. We have to remember that it is not always the newer, more novel, more comprehensive drug that comes to the rescue. The crucial answer often lies in seeing the fastest way to a solution.

“Last year, with the emergence of swine flu, we screened marketed drugs for effectiveness against H1N1 and in fact found drugs already on the market that weren’t known to have any anti-viral activity but could knock out the virus. At SRI, we celebrated our success and five minutes later went back to work because we know that there are always other current or approaching problems that demand our attention.”

Whatever pressing challenges the pharmaceutical and other 21st-century industries are forced to meet, the weighing and processing of an exploding increase in the mass of data will have to be streamlined as the rate of change continues to speed up, Moos said.

“I’ve already referenced Moore’s Law, which concerns the exponential advancement in computer technology. A similar ‘explosion,’ as Toffler predicted, is taking place in our continuing research in genomics. The changes in this field are amazing and multiplying at increasing speed, especially in terms of the amount of data that must be processed and the rising cost of responding to this avalanche of newly discovered factors. We will literally be overwhelmed with data and it’s vital that we’re able to transform this growing influx into useful information and knowledge for practical, timely application. We’re going to have to discover new ways to make data analysis and selection simpler at the same time that our work is rapidly expanding and becoming more complex.

“All of us in the drug industry are going to have to find new, quicker and more effective ways to bring promising ideas to life, whether we’re involved in explaining new concepts to colleagues and supervisors to convince them of the value of our discoveries; attempting to gain grants from foundations or federal agencies or money from investors; or persuading the FDA to approve a new drug.

“I’d like now to briefly describe a relevant example of the new, simpler strategies we’ll need for the handling and communication of complex data. My example is taken from a business meeting that occurred about a dozen years ago.

“One of my companies was working on mitochondria—many of you know that mitochondria are the ‘powerhouses’ of the cell. My colleagues and I were trying to explain to investment bankers at a very large Wall Street firm that mitochondria are the prime movers within individual cells, and that further research on mitochondria could be vitally important in developing new, more effective drugs to fight disease. We realized our audience wasn’t comprehending our presentation or its importance. When we returned to our hotel, we put all of our PowerPoint

skills together to develop an animation that for its time was state-of-the-art and went something like this:

“‘Here is a cell. Here, inside this cell, are hundreds of thousands of mitochondria. Later tonight, when you eat dinner, your food is going to provide fuel to this cell and to the many, many mitochondria inside this cell. As you can see, inside each mitochondrion there are four complexes of proteins. These protein complexes pass nutrients and electrons down a chain of proteins, to charge up the world’s smallest rotary engine, an enzyme known as ATP synthase. An ATP synthase that spins in the right direction creates ATP, and the ATP charges the mitochondria, which are the ‘batteries’ for the cell. Unfortunately, in diseases like Parkinson’s and Alzheimer’s, the rotary engine that creates the ATP can spin in the wrong direction. The wrongly spinning engine fails to create ATP to charge the mitochondrial batteries. With no charge to the batteries, blackouts or brownouts occur in the brain. This shutdown of energy can cause diseases like Parkinson’s and Alzheimer’s and that’s why well-charged mitochondria are so important. Without a good battery there isn’t any light.’

“After our presentation, the light bulbs went on in the investment bankers’ minds and we managed to get our financing successfully completed and move our programs forward. This is a very brief description of our simpler animated presentation, but the point to remember is that bringing complex processes to life for your listeners is critical, and a picture really is worth a thousand words.

“Let me show you the introductory clip from a video made to promote a project that was a collaboration of several government agencies and more than a dozen companies and universities, to create a ‘trauma surgery pod’ that could be dropped anywhere—into a remote region of Montana or Iraq or into a locale like Louisiana during a Hurricane Katrina or other natural disaster.”

**Video Voiceover:** “In trauma surgery, doctors and nurses talk about the Golden Hour. The Golden Hour is that hour when patients with critical injuries can be saved. The patient’s life depends on what is done in that crucial hour. No matter how effective our lifesaving medical inventions are, if they’re not used within the Golden Hour the patient will be lost.”

“The trauma pod was designed to deliver high-quality surgical and other lifesaving medical care during the Golden Hour,” Moos explained, “when other critical emergency services were unavailable or would arrive too late. Again, in a few moments, the pictures of what our pod could do spoke volumes as the images struck our viewers instantly, more powerfully and with more information than words alone could convey.”

In concluding his presentation, Moos praised Cal Poly’s energetic adaptability to the quickly and unpredictably evolving present world, whose challenging complexity he had outlined to his Baker Forum audience.



*“Let me close with Cal Poly’s credo: ‘Discere faciendo. Learn and do.’ As you respond to revolutionary change and discover new strategies to meet the unknown future, always keep that close at hand.” – Walter Moos*

“I think Cal Poly is dealing remarkably well with future shock. You at Cal Poly are doing all of the right things and that’s important, because we’re counting on you, all of us at SRI and in the wider community of innovators, of whom you’re a part. Without you and your efforts and the innovations you’ll develop and bring to the global market, our world will not become as good a place as we’d all like it to be.

“Let me close now, with a Latin phrase that you already know well, whether or not you’ve ever studied Latin: ‘Discere faciendo.’ It means, ‘Learn and do.’

“As you continue to creatively respond to revolutionary change and discover new strategies to meet the unknown future, always keep that Cal Poly credo close at hand—just as we at SRI keep in our pockets the printed card that reminds us of our mission and our goals.

“And remember: ‘Unless someone like you cares a whole awful lot, nothing is going to get better. It’s not.’

“Thank you so much for your kind attention. I’d be happy to answer any questions now from our audience.”

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## QUESTIONS AND ANSWERS

**Stephen Ciesinski:** “Thank you, Walter, for that sobering, riveting and—particularly for the younger listeners in our audience—very inspirational presentation on the dollars and ‘sense’ of pharmaceutical innovation. I’m going to ask our Baker Forum audience for questions, but first I have two of my own. Actually, I have about 10 questions, because I was jotting them down as you spoke.”

**Walter Moos:** “I’ve been writing down the answers, Steve, so I’m all set.”

**Ciesinski:** “I knew you were smart, but I didn’t know you were that smart! Let me begin with a rather provocative question, concerning the big pharmaceutical companies. I’ll use Pfizer as an example. ‘Too big too fail’ is a phrase all of us have heard all too often. Are Big Pharma companies like Pfizer so large that our government or some other entity will have to keep them operating if they fail to remain solvent?”

**Moos:** “That’s a good question, Steve. I don’t think any Big Pharma is too big to fail. Why? Pfizer makes \$40 billion to \$50 billion a year as its portion of the earnings of the

big pharmaceutical companies, which total over \$100 billion a year. We have in place an industry around Pfizer that in the case of Pfizer's failure could assume parts of the company and make them more profitable and productive. A very large organization that employs over 100,000 people is very difficult to manage, while a small company focused on one market niche can be very cost-effective and successful. A venture capital firm—and this has happened a number of times—can take pieces from a big pharmaceutical company and turn them into smaller companies that become worth more than the entire big company they came from. Unlike the financial industry, the pharmaceutical industry might benefit from a division into smaller, more streamlined companies."

**Ciesinski:** "I now want to follow up on your warning of a worldwide, infectious disease breaking out, one that could cause millions of deaths and an economic impact of \$3 trillion. Your description of a new pandemic was especially sobering. What would you do, if you were declared 'king of the universe' and it was your job to forestall or handle such a catastrophic situation?"

**Moos:** "You know, I applied for that job and I wasn't chosen—I think President Baker came closer to getting that position. But seriously, let's imagine for a moment what happens when a virulent, terrible 'bug' appears and spreads. Last year, when swine flu was infecting millions, we didn't do particularly well in confronting and containing it. Our response was somewhat similar to what we do when a large oil company installation catches fire—there's toxic smoke in the air and you shelter in a place that's as far away as possible from the point of emission and the blowing fumes. There are a number of flaws in our current system of responding to pandemics and I'll only mention the main weak spots.

"At the governmental level, there is no single person or agency in charge. The NIH does its usual day-to-day work, much of it through committees, but a pandemic can't be successfully fought by committees. They take too long to take decisive action, and people would be dying in large numbers while the health professionals tasked with combating the emergency were organizing themselves and trying to reach a consensus for response. We have the Biomedical Advanced Research and Development Authority [BARDA], the Department of Homeland Security, the Defense Threat Reduction Agency [DTRA], and the Army and Navy, but all of these groups have their own functions and are not coordinated with one another in a way that would allow the formation of an emergency team that could take successful action.

"Another real problem is that we've sent so much of our manufacturing capacity offshore, which we shouldn't have done. What would happen if we suddenly needed ciprofloxacin and all of it was made in China and China needed all of the drug for its own population?

"There are many missteps in organization and preparation that our government and American companies have put in place that would make stopping a pandemic difficult. What we can do is to break down our overall response into phases:

“First, when a disease appears that could develop into a pandemic, we need certain drugs to boost the immune system. We need to provide early responders with effective immune-system boosters that they can quickly distribute. Some of these drugs can be stockpiled for emergency use. We’ve started stockpiling but we haven’t done enough and we’re going to have to spend more money.

***“Woody Allen once said that ‘80 percent of life is showing up,’ and as it turns out that’s true for drugs, especially when a health crisis occurs.”***  
***– Walter Moos, Vice President, Biosciences Division, SRI International***

“Second, we need a pharmaceutical that’s going to work in the mid-term, which would probably mean an antibody project. Polyclonals have gone out of favor, but they would work—they were named ‘poly’ because they fight a whole range of infections.

“Third, we would need to test the effectiveness of drugs we already have, to see if any of them might unexpectedly work against the disease. Woody Allen once said that ‘80 percent of life is showing up,’ and as it turns out, that’s true for drugs, especially when a health crisis occurs. Drugs already on the market have been deemed safe enough for use and there would be a good chance that some of them would reach and protect parts of the body that the disease attacks. You’d be amazed at how many drugs not specifically designed for a particular disease prove to be effective, because they are selective toxins and that’s what you need to destroy the bug before it kills the patient.”

**Ciesinski:** “Let me now turn to the audience for questions.”

**Christina Bailey:** “Thirty years ago drugs that were or might be dangerous were eliminated at phase 1 or phase 2 of drug discovery and development. Now, we’re seeing drugs recalled at the phase-3 stage, and even some drugs at the post-marketing phase-4 stage, which involves drugs that are already on the market and being taken by consumers. A lot of drug-development money is going down the drain because harmful or potentially harmful drugs reach phase 3 or 4 before health alarms go off, frightening the public.

“First of all, what can be done to prevent new drugs from entering the later phases of development before they are identified as having serious side effects, at least for some patients? And second, what can be done to better educate the public about certain drugs that frighten patients but in reality present minimal risks, especially those drugs whose side effects have a low probability of occurring or causing serious harm?”

**Moos:** “A great question—Steve didn’t tell me that there were going to be ‘ringers’ in the audience.”

**Ciesinski:** “Oh, we’ve got some very smart people around Cal Poly.”

**Moos:** “Let’s say that you work for 20 years and finally deliver a billion-dollar product to the market, only to see it fail and become a perceived menace to public health instead of a breakthrough wonder drug, as happened with Vioxx and some of the recent diabetes drugs. How do you avoid that?”

“The problem is a large and costly one—to study 10,000 patients taking a new drug means a huge, very expensive clinical trial, which can cost \$50,000 to \$100,000 per patient. And every human being is unique, with his or her individual body chemistry. It’s true that a bell curve for those 10,000 patients who take part in trials—and usually only 1,000 or 2,000 patients are studied—will identify possible side effects and eliminate the potential for surprising, undetected side effects occurring. But there are always going to be ‘outliers,’ human exceptions whose responses fall outside the range of tested and expected chemical responses to a drug. Obviously, it would be impossible to sample a whole population.

“Several approaches to the problem of new drugs with unexpected side effects reaching stage 3 or 4 have been proposed but none has been accepted yet. The Critical Path Institute—the new nonprofit in Tucson, Arizona, that SRI helped co-found with the FDA—proposed that we actually release drugs in phase 2, but only to a numerically limited, very well-defined population. The plan calls for hiring more pharmacy technicians who would do follow-up with patients who fill their prescriptions at neighborhood drugstores. A person from the pharmacy would phone your grandmother and ask, ‘How are you feeling today? Do you feel any different than a few days ago?’ And the druggist and pharmacy staff would see their customers in the community and could spot any early warning signs.

“Under this plan, a company wouldn’t launch a new pharmaceutical with the expectation of having produced a billion-dollar drug. Instead, the company would launch to a very small population in a determined location, so that it could carefully monitor the dispensing of the drug and watch vigilantly for side effects that might be serious. A company would introduce a new drug very slowly, and if any danger signals appeared, distribution could be quickly stopped and fewer patients would be hurt than by an immediate, mass sale of a drug that caused unexpected side effects.

“Of course, another potential strategy uses biomarkers. The biomarkers plan is complex to carry out and based on very new science. Ultimately, I do think that patients chosen to take part in clinical trials will be selected by analysis of their genes and blood, or by some other biochemical profile technique that would allow the drug maker to say, ‘Yes, this patient is likely to react well to this drug and unlikely to develop side effects to other similar drugs that we’re working on. This drug is good for this patient—this is a good patient for this drug.’ The ideal is that patients picked for the clinical trial would all show the drug’s immediate positive effects and none of the side effects, because patients prone to potential side effects would have been excluded from the trial by their biomarkers.

“Using biomarkers would make clinical trials much faster and much less expensive. Still, the

company would have to be very careful in releasing the drug onto the market—if great numbers of people immediately began taking the drug, side effects would become more likely to appear.

***“As we teach more about the world of pharmaceutical production, I think that it is important to bring our work more vividly to life for our students and the public.”***  
**– Walter Moos**

“The other important question you raised was, ‘How do we better educate the public?’ I hope that the PowerPoint slides that I’ve shown today contributed to education. Teaching about pharmaceutical research and development is steadily increasing within the universities. We’ve found that most students—as well as the general public—really don’t have a clear understanding of the positive impact successful drugs make in the lives of millions of people. And it’s sometimes difficult for 18-year-olds to grasp the reality of an average 20-year timeline for discovering and developing a new drug. It’s very hard for them to comprehend an environment where scientists do intensive work on one drug over so many years.

“As we teach more about the world of pharmaceutical production, I do think that it is important to bring our work more vividly to life for our students and the public. Many times scientists become so buried in the technical aspects of their research that they can’t effectively communicate the important work that they do. Conversely, as STEM [science, technology, engineering and mathematics] education continues and increases, new university students and the at-large population should be better prepared to meet scientists ‘halfway,’ bringing a better understanding of science as scientists work harder to clearly describe the research that they do and the important products that flow from their science.”

**Jaime Oaxaca:** “I have three questions. The first is about the way the medical profession fought the swine flu and how it decided which age groups should take medicines to prevent infection. I remember hearing that it was more important for younger people to take the pill than it was for the older population. My second question has to do with genetics. Have scientists taken into proper account the life spans of patients’ parents, when there is a limited supply of drugs to dispense and doctors have to choose who should receive the drug and in what dosage? Should there be a databank that protects personal privacy but contains important family medical history that would indicate which patients might be most at risk and those patients who have genes that promote good health and longevity?”

**Moos:** “You mentioned ‘triage,’ which is the process of prioritizing sick or injured people for treatment, according to the seriousness of their condition or injury. Triage was part of the fight against swine flu. Medical professionals found out pretty quickly that it was the younger population who was more at risk and needed to be treated aggressively, setting aside very young children and infants who might be harmed by the anti-viral drugs. It has now been shown that people who were alive in the late 1950s and late ’60s and contracted the Hong Kong or the Asian flu, or were at least exposed to one or both, do have some natural immunity to swine flu and that’s why the older population wasn’t as vulnerable as younger people were.

“Triage was carried out because there weren’t enough vaccines and oral drugs. Decisions were made, protocols were set up and flowcharts were created that reflected age and health status. Respiratory function was factored in, to determine whether the patient was likely to progress to pneumonia—many of the patients who died developed a bacterial super-infection on top of the viral infection. The triage process could have been better done, but it was part of controlling swine flu.”

**Oaxaca:** “What about genetics and databanks?”

**Moos:** “For many decades, doctors have been taking patient histories, and really good doctors have patients’ family health histories at hand and keep them in mind as they make their physical examinations. You need to have a doctor who knows you, who has done a full medical history that includes all the pertinent information about your family’s health. If you walk into an unfamiliar clinic and the doctor doesn’t know you from Adam and if there is no electronic health record to consult, the doctor is going to have a hard time taking into account both your and your family’s past medical information.

“That’s why it’s important to have a close relationship with a physician or physicians who know your medical history, who have the health histories of your parents and your siblings. If there is heart disease in your family, your doctor will want to keep your blood pressure down and will probably suggest that you take a statin to keep your lipids regulated. Doctors who know their patients well do a pretty good job of considering family history in helping their patients maintain good health.”

**Ciesinski:** “Walter, your industry is one of our nation’s most closely regulated industries. In your presentation you touched upon the work of the FDA, the regulatory body that oversees drug production. What do you think about the FDA? Is the FDA largely responsible for the rising cost of drugs, the relative scarcity of new, effective drugs, and the extended time new drugs take to get to market? Should there be alterations or modifications in the FDA’s process for licensing drugs, or do we need another federal agency that could help make more new drugs available sooner, at lower prices?”

**Moos:** “Wow! Do I have another hour?”

“As you know, there are a lot of good people at the FDA, just as there are a lot of good people at the European Medicines Agency [EMA], which is the FDA’s European equivalent. I think both entities are doing the best they can, and many of their administrators and personnel are very conscientious and talented and have been at their jobs a long time. Janet Woodcock has been with the Center for Drug Evaluation and Research [CDER] for many years and is very effective.

“You have to remember that the FDA operates under a number of limitations. For example, on its own the FDA can’t bring together for-profit organizations to do needed work and share knowledge, because of antitrust rules. Again, taking on joint efforts based on teamwork is an



area where a nonprofit, whether it's an organization like SRI or a university, can really help the process of drug development. Earlier I mentioned the Critical Path Institute, which SRI co-founded with the FDA. C-Path created a neutral ground where companies could share data and samples and the FDA could freely come in and observe the work that was being done.

***“Taking on joint efforts based on teamwork is an area where a nonprofit, whether it's an organization like SRI or a university, can really help the process of drug development.” – Walter Moos***

“One important advance that we made was developing markers for kidney toxicity, which is often a problem with cancer drugs. Using the slow, normal monitoring methods, kidney toxicity can't be detected until it's too late and irreparable damage has been done to the kidneys. At the Critical Path Institute, by sharing samples and data, the team and many corporate partners were able to construct a new toxicity test that produces results in 24 hours and not the month other testing technologies require. Creating a neutral ground where public/private partnerships can take place and thrive speeds the process of discovery and increases the effectiveness of innovations.

“There is another important issue that I need to address, which involves government policies that often hurt the pharmaceutical industry. Before my speech I mentioned in conversation that drug makers are often considered guilty until we're proven innocent, that our business is regulated on a 'punishment model.' Now, most of the people that I know in this industry are trying to do the right thing and like most of you they respond much better to incentives, to positive reinforcement. A government policy that says, 'This change is going to make your industry more stable,' or 'We're going to provide a large monetary incentive to help you develop and deliver to market a drug for a neglected disease' provides a carrot and not a stick.

“And as a society we need to shed the crazy, commonly held notion that everyone in the pharmaceutical business is bad, that scientists and physicians involved with the pharmaceutical industry are suspect, and that doctors who have consulted for drug companies are guilty of a conflict of interest. Denying experienced professionals a place on panels that review new drugs is an unwise, counterproductive and dangerous practice. Too often drug-review panels are made up of people without the proper medical or pharmaceutical experience, who don't know or understand the disease that a new drug is designed to fight.

“Imagine that you were going to a heart doctor and that doctor prescribed a drug that had been approved by a review panel whose members had no training in cardiovascular medicine. We need the best people, the most experienced people, analyzing a new pharmaceutical, and we shouldn't restrict membership on panels to people who have never worked within the industry or been associated with it. Panels should represent a cross-section of medical and pharmaceutical professionals—if a 'bad apple' somehow gains access to a panel, then the other experienced and honorable members can identify the conflict of interest and discount the compromised input. Wouldn't you agree that the smartest, most well-informed people should be the ones to decide whether a new drug should reach the marketplace, a drug that you and many others might take

tomorrow?”

**David Christy:** “In your presentation you referenced Toffler’s prediction of a genomics revolution, and you’ve just mentioned biomarkers that would select patients for clinical trials by their genetics. I wonder if there is a movement to develop drug products that are customized to fit the specific biochemistry characteristics of individuals? What sort of manufacturing ‘platform’ would be needed to easily make these drugs in a dependable, standardized way?”

***“The personalized medicine movement is strong, and scientists are working hard at personalizing the medicines individual patients need.” – Walter Moos***

**Moos:** “Yes, Dave, you’re right on target. The personalized medicine movement is strong, and though it will take a long time to yield practical, everyday results that become part of our regular health care, scientists are working hard at personalizing the medicines individual patients need.

“New personalized medicines can be described by an analogy: Say you go into a paint store and you need or want a certain color. The paint expert dips a little bit of one shade and a little bit of another shade and notes down the formula, so that the paint that’s mixed can be reproduced, because it ‘works’ for you, though it might not be right for someone else.

“Paul Janssen, a Belgian doctor, and one of the legendary figures in medicine, worked on research at Johnson & Johnson and as a pharmacologist he experimentally produced drugs as in my analogy of the paint expert. Janssen began with so-called ‘dirty drugs,’ pharmaceuticals that produced different effects at different levels of dosage and caused varying reactions, depending on the patient. He studied patients’ biochemistries and was able to develop categories, so that he could vary the characteristics of dirty drugs and develop the right mix for one patient population and a different mix for another category of patients.

“Janssen’s work showed that personalized medicines can work. We just haven’t developed the ‘manufacturing platform’ you mentioned for reproducing these individualized drugs. The concept is valid and researchers are studying techniques and strategies for easily replicating specific formulas for specific groups of patients.”

**Unny Menon:** “Dr. Moos, thank you very much for a message that is very encouraging to our students. I want to ask a question that I think raises a moral dilemma for the pharmaceutical companies, a problem that concerns the world’s vast number of poor people in need of lifesaving drugs. You presented the troubling fact that in economically depressed populations people spend large portions of their small incomes for what we in the first world would consider inexpensive pharmaceuticals, and often they unknowingly buy counterfeit drugs. What are the attendant moral problems when important new drugs appear on the market and are very expensive?

“For example, Avastin is a wonder drug that costs tens of thousands of dollars even in the United States. How can expensive drugs like Avastin be made available to those in the world who can



least afford them? We know that the Bill and Melinda Gates Foundation is commendably targeting billions of dollars to bring drugs to those in need. Can the big pharmaceutical companies do more to deliver pharmaceuticals to the world's poor, more than they are apparently doing now? Certainly the drug companies' huge investments have to return a profit, but aren't there solutions to this problem, which exists on a global scale?"

***"Pharmaceutical companies should give away more of the drugs that they produce to communities that can't ever afford to pay for them, and our government needs to play a bigger role by creating more incentives."***  
***– Walter Moos***

**Moos:** "There are solutions, provided that we can keep our borders closed to the re-importation of American-made drugs, a statement that I know may be controversial. Pharmaceutical companies should give away more of the drugs that they produce to communities that can't ever afford to pay for them. Our government needs to play a bigger role, by creating more incentives like the one it recently put in place, which provides a voucher for any company that takes a neglected-disease drug to market. That voucher allows 'fast-track' status for the next drug that the company produces.

"Under this new policy, a voucher that streamlines the FDA's licensing procedures can bring a drug company several hundred million dollars in income, a profit that can be figured by simple mathematics. If you've got a drug that earns \$365 million a year, that's an income of a million dollars a day—for every day you lose in getting a drug to market, you're losing a million dollars. The voucher guaranteeing the fast-tracking of the next drug produced gives the drug companies a very significant head start in delivering new drugs to the public and in making a profit. Again, 'carrots, not sticks' is the right approach.

"I should also say that domestic pharmaceutical companies would be more generous in supplying drugs to poor populations if our government would impose appropriate limitations on drug companies in other countries, to prevent them from doing harm to pharmaceutical innovations taking place in the United States.

"Yours is a very good question, because in poor parts of the world the cost of a needed drug might amount to more than an entire village earns in a year."

**Ciesinski:** "Dr. Walter Moos, thank you so much for spending time with us, for sharing your 'dollars and sense' experience of the pharmaceutical industry and for reminding all of us that innovation really is our only path in this age of accelerating future shock. Your insights are well received by this audience."

*(Applause)*

**Ciesinski:** "I know that President Baker has been furiously taking notes as Dr. Moos guided us

through the multifaceted world of modern pharmaceuticals but I see that he has put down his pen and would now like to present a special gift to Dr. Moos.”

***“We thank Dr. Moos for his presentation on a complex, important and often misunderstood part of the world health-care system, and for his informed insights about the opportunities awaiting Cal Poly bioscience graduates.”***  
***– Warren J. Baker, President, Cal Poly***

**Warren J. Baker:** “Dr. Moos, thank you very much for your wonderful presentation on a complex, important and often misunderstood part of the world health-care system. In our meeting today before the forum began, you also offered many informed insights in answering our questions about the opportunities awaiting Cal Poly bioscience graduates.

“In thanks for your generous expertise, I’d like to give you a small token of our sincere appreciation—a history of Cal Poly and its learn-by-doing philosophy that joins knowledge and experience. Your presentation has been recorded and a transcription will soon be available to our students online and will provide them with a strong incentive to think deeply about innovation and the related, important issues you’ve raised today.”

**Moos:** “Thank you so much, Dr. Baker.”



## **OVERVIEW OF CAL POLY INNOVATION INITIATIVES**

**Robert D. Koob  
Provost  
Cal Poly**

**Susan C. Opava  
Dean  
Research and Graduate Programs  
Cal Poly**

Stephen Ciesinski opened the “Overview of Cal Poly Innovation Initiatives” portion of the 2010 Baker Forum by calling upon Provost Robert Koob to introduce Dean Susan Opava, who would help set the context for the day’s discussion by describing existing and planned efforts to support innovation at Cal Poly.

***“We’d like to encourage and support innovation more intentionally as we look toward the future.” – Robert Koob, Provost, Cal Poly***

“Susan Opava has kept her hand on the pulse of innovation and research at our campus for a long time,” Koob told his audience. “Her role in support of research at Cal Poly has grown rapidly in recent years, at the same time that the state has pulled back on its commitment to support public higher education. But the state’s change in direction is not our focus today. The focus today is on innovation, which we have supported for quite some time here at Cal Poly. We’d also like to encourage and support innovation more intentionally as we look toward the future. To begin that conversation, Susan will describe programs and activities already in place that cultivate a spirit of innovation.”

Opava began her presentation by posing a question: “Over the years, how effectively has Cal Poly fostered innovation by following its learn-by-doing philosophy of education, which encourages hands-on experience, and by putting theory into practice to develop problem-solving skills and ingenuity?”

Opava emphasized the word “ingenuity,” which she defined as “the quality of being cleverly inventive or resourceful,” noting that “inventiveness” and “genius” are synonyms for “ingenuity.”

“I think we do see that quality in Cal Poly students, and I believe it is tightly correlated with our university’s core emphasis on experiential learning. All of our students must complete a senior project that, in theory, should be an original contribution to their chosen field. Many senior projects are driven by ‘real-world’ problems and challenges, and some are the result of work that students have carried out at a company during an internship.”

In praising the spirit of creativity at Cal Poly, Opava added a caveat, noting that the senior projects program would be undergoing a general review to determine the “ingenuity quotient” of students’ work.

“I said that ‘in theory’ Cal Poly senior projects make original contributions to knowledge within their specific academic disciplines, but at Cal Poly each year we have between 3,000 and 4,000 students working on and completing senior projects, and we cannot be certain that every project actually achieves the desired goal of originality. Erling Smith, who is responsible for academic program review, has decided to study senior projects closely in the next round of evaluation, to determine whether the results of these projects reflect the innovative study and research for which the senior-project requirement was designed.”

Opava next highlighted important activities that take place outside required classroom and lab work that often involve competitions with other universities and exemplify “non-required” ingenuity in action among Cal Poly students.

“I believe that Cal Poly has stimulated much creativity in the area of extracurricular and co-curricular activities that students undertake through clubs or in special enterprise projects like those that are a hallmark of the College of Agriculture, Food and Environmental Sciences. Two resonant examples of ingenuity at work to solve real-world challenges are the ‘super-mileage’ vehicle that students developed and drove in a national competition, and the ‘solar house’ designed and built by students in the College of Architecture and Environmental Design.

“National competitions that student teams enter require that they adhere to strictly set standards and exercise innovation within carefully outlined boundaries to achieve a target goal. Cal Poly took first place in the super-mileage competition a few years ago, with a vehicle that got 1,900 miles to the gallon, and recently built a vehicle that ran 2,000 miles on a single gallon of gasoline and received a second-place prize. The solar house built by Cal Poly students operates solely on energy from the sun and won awards for design and efficiency.

“The low-mileage car and the house fueled by sunlight show our students directly involved in discovery and innovation outside traditional coursework.”

Underscoring that the success of “out-of-class” activities indicates that Cal Poly has created an environment that fosters creativity, Opava described two student projects that exhibited special ingenuity in entrepreneurship and that have developed into successful commercial enterprises.

“The first company, iFixit.com, was started by Kyle Wiens when he was a Cal Poly undergraduate. His company allows customers to study and learn from its Web site and then repair their own Apple products. The site disassembles the Apple products so that all of the components can be viewed, and sells the consumer needed parts to mend Apple equipment by following do-it-yourself manuals that Kyle’s company produces. The success of Kyle’s business—it now has 20 employees and earns more than \$2 million in annual sales—has

allowed him to stay within the San Luis Obispo community and contribute to our local economy. I find it especially interesting that when the iPad appeared on the market, employees of Kyle's company were among the first in line to purchase the new technology and within two hours had taken the iPad apart and were displaying its components on the iFixit Web site.

"The second company is UrbanDictionary.com, which was begun by Aaron Peckham when he was a freshman at Cal Poly. Aaron has developed a Wiki-like site that allows users to learn about and discuss new words, especially colloquial, slang terms that are continually emerging in the urban culture. Since 1999, the Web site has listed almost 5 million words and their definitions, and UrbanDictionary.com ranks high in Internet traffic—532nd among sites across the world, and 278th in the United States. There are almost 19 million sites that link to UrbanDictionary—a measure of the Web site's achieved reputation."

Opava then turned to specific programs Cal Poly has put in place to encourage innovation, describing four areas in which developing and increasing creativity is under way:

- Faculty-centered support and resources
- Student-centered activities and opportunities
- Community-based economic evolution, stimulated by Cal Poly's emphasis on practical ingenuity
- "Cross-cutting" programs that encourage inventiveness among faculty and students and that involve community outreach

A prime goal of each effort, Opava stressed, is to stimulate greater numbers of Cal Poly's students and faculty to prize and exercise ingenuity as a means of meeting the growing needs of society while successfully advancing their own chosen professions and careers.

"First, let me describe our faculty-centered support and resources. Jim Dunning is the project administrator for the California Central Coast Research Partnership, or C3RP. Many of you have worked with him and been involved in our efforts to develop a technology park on campus, an endeavor that has been carried out under the umbrella of the C3RP organization that we created within the university in 2002, using earmarked funds from the federal government.

"One message that I often share is 'All "pork" is not bad,' that some earmarked funding is very worthwhile and beneficial, especially monies that help support educational institutions and nonprofits that otherwise would not have access to needed financial aid. Federal funds have been critical for Cal Poly, enabling us to do outreach to industry through Web sites, print materials and one-on-one meetings. In recent years we've been holding regular industry breakfast forums, where we bring local technology-based companies to campus for a mutual exchange of information, and a strengthening of the relationship between the university and the technology firms in our region.

"At the C3RP technology park the first building should be completed this month. Already Applied Technologies Associates—a Paso Robles company that develops sensing equipment

***“Cal Poly’s new technology center will offer opportunities for students to work with commercial firms and receive valuable experience in research, development and commercialization as the companies create new services and technologies for the marketplace.” – Susan Opava, Dean, Research and Graduate Programs, Cal Poly***

for the oil and gas drilling industry—has signed a lease for space and will locate a product development group in the park. We’re also in the process of finalizing other leases for other entities wishing to be a part of C3RP. We believe that Cal Poly’s new technology center is going to be a very successful and fruitful partnership for both the university and for companies in residence. The park will offer important opportunities for students on campus to work closely with commercial firms to gain and exchange knowledge and to receive valuable experience in research, development and commercialization as the companies create new services and technologies for the marketplace.

***“The funding Cal Poly received to launch C3RP has also allowed the university to develop a tech-transfer office, and to provide almost \$1 million each year to new faculty who are starting research programs.”***  
***– Susan Opava***

“The funding Cal Poly received from the government to launch C3RP has also allowed the university to develop a tech-transfer office, and to provide almost \$1 million each year to new faculty who are starting research programs—programs that will support our learn-by-doing strategies and advance Cal Poly’s emphasis on innovation.

“We’ve also devoted some internal funding to provide needed assistance to faculty pursuing research, so that they can become even more competitive within their fields and gain increased external funding via grants and other sources of academic support. Our individual colleges have efforts in place to recruit faculty interested in applied research and to financially assist them in advancing professionally as they make innovative contributions to their areas of specialization.”

***“The sponsored-project funding at Cal Poly for 2009 was almost \$29 million, a 66-percent gain over the previous five years. This not only capped a five-year period in which there was an increase every year, but made 2005 through 2009 the first five-year span in Cal Poly’s history in which project spending surpassed that of each preceding year.” – Susan Opava***

Cal Poly’s determination to support faculty research is reflected in rising dollars-and-cents support, Opava told her audience.

“The sponsored-project funding at Cal Poly last year was almost \$29 million, a 66-percent gain over the previous five years. This total for 2009 was not only a new high for the university but capped a five-year period in which there was an increase every year, making 2005 through 2009

the first five-year span in Cal Poly's history in which project spending surpassed that of each preceding year. This sustained growth in financial support for new and ongoing Cal Poly projects reflects the success of the collective efforts that I've described."

Patents that have been granted for inventions and improved techniques developed by Cal Poly faculty also indicate the success of the university's support for innovative research and development, Opava said.

"We now have a portfolio of patents and are beginning to become involved in licensing activities. During the 2008-2009 year Cal Poly filed one provisional patent application, four non-provisional or regular utility patent applications, and had two patents issued.

"One patent was granted for work done by Tali Freed, a professor in our industrial manufacturing engineering department. Freed's innovation involved radio frequency identification [RFID] tagging of reusable plastic agricultural containers. On farms, produce is packed in recyclable containers that are shipped to our grocery stores. Professor Freed developed a procedure for combining an RFID tag with the standard bar code, safely encasing the tag so that it can survive up to 100 cleanings and sterilizations and still function.

"The second patent was granted for an ingeniously simple, low-tech water-purification system designed for 'in the field' use. This innovation has three components: a plastic bag, a filter and a supply of a purifying chemical. Muddy water from a puddle can be rendered safe and supply a family in dire need with several days of pure drinking water. This device could have been successfully deployed in Haiti after the earthquake but unfortunately it is still in production, though we hope it will soon be available for future disasters and as a stop-gap means for disadvantaged people around the world to purify their drinking water until more sophisticated, expensive systems can be introduced."

Cal Poly has made four new invention disclosures and has 11 other patent applications that are being processed, Opava said, adding that patenting is often a drawn-out process.

"Those of you who have had experience with patents know that sometimes you may have a long wait for the U.S. Patent Office to come to a decision. Getting the RFID patent was a process that spanned several years, although there are sometimes gratifying surprises. The patent for the field water-purification system was issued in six months, perhaps because the technology was uncomplicated and the device wasn't in competition with any prior invention."

Next, Opava described two licensing agreements that Cal Poly has under development that could place new inventions on the market and create revenues.

"One invention is a medical instrument, an oral airway device that was developed by a local anesthesiologist in conjunction with our faculty in industrial technology. Keith Vorst, a Cal Poly polymer chemist, and his colleagues contributed to the design and worked on the selection and



formulations of the materials for this medical innovation.

“The other invention concerns novel DNA primers that can be used to identify bacteria that metabolize or oxidize butane and methane. The presence of these bacteria in the soil is an indication of existing oil deposits under the soil. A company has shown interest in developing a field testing kit that can be used in prospecting for oil and natural gas.”

Opava then described some of the special efforts Cal Poly has made in student-centered activities to stimulate and increase a spirit of ingenuity.

***“In the Orfalea College of Business there has been a systematic revision of courses and a creation of new courses, with the goal of encouraging entrepreneurship, technology development and commercialization.”***  
***– Susan Opava***

“Cal Poly has instituted many new course offerings and academic programs, the greatest number of additions taking place in the Orfalea College of Business, where there has been a systematic revision of courses and a creation of new courses, with the goal of encouraging entrepreneurship, technology development and commercialization. The college of engineering in some of its departments has also made changes along similar lines.

“The college of business has developed an entrepreneurship concentration, which is not only for business students but welcomes students from all majors. In addition, there is a newly revised master’s in business and technology, which was formerly a master’s in industrial technology. This re-focus addresses more aspects of the process from product development to commercialization to marketing, with a special emphasis on entrepreneurship skills.

“Since 2002, the college of business has offered students the opportunity to enter its Ray Scherr Business Plan competition. Students submit business plans and the college works with local businesses in judging and providing feedback for Cal Poly’s future entrepreneurs.

“The Innovation Quest program, which was started several years ago by Carson Chen, a Cal Poly alumnus, is designed to uncover some of the ideas and inventions that students have developed but for which they haven’t found an interested audience or market. Students need a place to go with their ideas, to talk to experienced business people who can offer insights and strategies. Some student innovations may be breakthroughs that will be further developed, while others may be interesting but presently economically impractical.

“The important aspect of the Innovation Quest program is for students to gain a knowledgeable, sympathetic hearing for their creativity. For many years now Carson Chen, Laura Pickering, Rich Boberg and other Cal Poly alums have organized the Innovation Quest contest and provided cash awards for the best student ideas. This year’s contest has just ended and the award dinner will be held Friday night, when the Innovation Quest winners will be announced.



“In the college of engineering, we have the Project-Based Learning Institute, which was created so that industry could provide real-world problems and projects for students to work on in interdisciplinary teams. The focus of the learning institute is to foster a team approach, in the way that projects are undertaken in integrated systems engineering. The experience of working as a team member to achieve a common goal should be very beneficial for our future graduates, no matter what fields they pursue.

***“What is the role that Cal Poly should play in furthering San Luis Obispo’s vibrant, innovative business culture?” – Susan Opava***

“Thanks to the generosity of Paul Bonderson, Cal Poly has the wonderful Bonderson Projects Building, where innovative research and development in engineering is always taking place. On this Sunday afternoon, students from the Robotics Club were at work there, building robots that one day may transform many aspects of our lives.

“I want to note the very important work Russ Bik has undertaken in advancing Cal Poly’s efforts to encourage entrepreneurship. Russ has begun a program in which students on an ‘entrepreneurship project team’ work together on a product that Russ has created, to further develop and commercialize it and get it to market. Russ sets up the entrepreneurship project as a small business would operate—some team members are in charge of the scientific technology aspects, while others handle marketing, sales, finance and related matters. Under Russ’ supervision, students gain invaluable experience in putting together a start-up company.

***We hope that the university can assume a central role, as a source of new ideas and inventions, and that the community can commercially develop promising innovations that germinate on campus.” – Susan Opava***

“I need to again underline the fact that expanded faculty research and the interest of faculty in promoting innovation have measurably extended the opportunities that our students have to work on creative projects. Within the California State University system, Cal Poly ranks highest in the number of students who are actively engaged in faculty research projects.”

Opava next described community-based areas of interest in which Cal Poly is examining how innovation can become more a part of the local economy and business activity.

“Recently, we’ve begun to work cooperatively with the community, to examine and analyze the elements of the local entrepreneurial ecosystem. The questions we’ve asked are: ‘How many new, innovative businesses do we presently have in San Luis Obispo? If we don’t have them, or don’t have them in sufficient numbers, what can we do to help create them? What is the role that the university should play in furthering a vibrant, innovative, local business culture?’

“We hope that the university can assume a central role, as a source of new ideas and inventions, and that the community can commercially develop promising innovations that germinate on

campus. Participants in this group pursuing a greater interplay between Cal Poly and the business community include representatives from Cal Poly, members of the board of supervisors, personnel from the city administration of San Luis Obispo, the chamber of commerce, and local businessmen and businesswomen.”

The fourth area of Cal Poly activity directed toward increasing innovation involves the work carried out at the university’s “centers of excellence” and institutes, Opava said.

“In my introduction to Cal Poly programs that stress ingenuity, I referenced ‘cross-cutting’ efforts that ultimately impact the greater community beyond the university and that emanate from within impressive entities on campus, many of them new. I have only time to highlight a few of these special sources of innovative learning and doing.

“The Center for Excellence in Science and Mathematics Education [CESaME] has been in existence for a number of years, and innovation has been an abiding emphasis there—especially in the effort to encourage more undergraduates to pursue teaching careers in K-12 math and science, and to improve instruction in those vital subjects by better preparing our future and current elementary and high-school teachers. This important focus on more effective, modern and more engaging math and science study within our public schools originated primarily through the STAR [Science Teacher and Researcher] program, a concept of President Baker’s that is now being put into application.

“The guiding idea of the STAR program is this: If we want high-school and middle-school teachers to remain creative and innovative, then we have to involve them in relevant professional research and career work outside their classrooms. Teachers who have degrees in math or science must continue to have meaningful contact and experience with their chosen fields, in out-of-class study and application that keep them significantly involved as active scientists and mathematicians and allow them to become even better instructors able to inspire their students to consider careers in science and math.

“From the list of Cal Poly innovation centers, let me mention the Global Waste Research Institute, which focuses on waste management and the recycling of all manner of waste material. We also have a new center for sustainability in the college of agriculture: The Sustainable Agriculture Resource Consortium concentrates on best practices in sustainable agriculture. At the Planning, Design and Construction Institute, within the college of architecture’s city and regional planning department, faculty and students are working on policy development, urban planning and important related areas of increasing concern.

“I earlier described a few of the many exciting changes taking place at the Orfalea College of Business, which in the next few weeks should gain approval for a center that will focus on education and outreach in the area of entrepreneurship and innovation and will serve as a universitywide resource. And I think it’s important to note that the college of liberal arts also has its new Emerging Technologies, Policy and Ethics Center [ETPEC]. This center is

dedicated to developing policy concerning the impact on society of new innovations and studying the ethics of emerging technologies, such as nanotechnology.

“I would now be happy to answer any questions you have about Cal Poly and the spirit of ingenuity on our campus.”

**Stephen Ciesinski:** “Thank you for the thoroughness of your interesting presentation. I’ll now ask for questions from our audience.”

\* \* \*

## **QUESTIONS AND ANSWERS**

**Jaime Oaxaca:** “Is there a way to apply Cal Poly’s emphasis on innovation and entrepreneurship within our high schools in California, to give science and math students encouragement to pursue careers in those fields, and to give them a head start in developing a talent for ingenuity before they reach our universities?”

“At Manual Arts High School in inner-city Los Angeles, a man named John Santos has a robotics program, and his students—most of them from very low-income families—have won national championships in robotics competitions. Santos’ students are making successful transitions from underprivileged backgrounds to future careers as scientists and engineers. Are there efforts under way at Cal Poly and other California State universities to help current high-school students, especially those who are economically disadvantaged, become enthusiastic about science and math as real career possibilities and to prepare them to gain entry and succeed at Cal Poly and other four-year universities?”

**Susan Opava:** “I’m happy to say that through Cal Poly’s Project-Based Learning Institute we offer many programs to encourage current high-school students to consider and to prepare for careers in science and math. The institute has a summer camp on campus for high-school students interested in engineering, and we have many other educational activities designed for public-school students in San Luis Obispo County.

“The STAR program is really trying to address the need to inspire and encourage students in high school. Teachers are able to study and work at research organizations and national labs during the summer, and in the fall they have a wealth of new experiences to share with their students.

“And at Cal Poly we award grants to bring teachers to campus and show them creative science-and-math teaching techniques that they can take back to their classrooms.

“Instead of the traditional and dry ‘cookbook’ labs that we were exposed to in school, many of today’s students in elementary and high school have a chance to receive creative, hands-on

instruction and to discover science as an exciting career opportunity. I think I'll limit my answer to programs we've put in place at Cal Poly, rather than address what work the CSU system and individual universities are doing to encourage science and math students within our public schools."

***"Many of our faculty are eager to have an innovation licensed and brought to market or to start a company to produce and distribute a patented invention."***  
***– Susan Opava, Dean, Research and Graduate Programs, Cal Poly***

**Oaxaca:** "I suppose my question was meant to suggest that our state education policy for science and math instruction might be improved through a more focused curriculum, to better prepare students for success at college. Instead of requiring high-school students to take four years of science, math, English and other subjects, the field of study could be both limited and streamlined, along the lines of a university major. Perhaps a high-school graduate and future engineer should already have four years of instruction in electronic or informational technology before he or she ever enters the university.

"My point is that our high schools could then serve as mini-universities, capable of sending well-prepared students to four-year institutions where they could immediately continue in the field they've already intensively studied. Students would be well prepared to do work in their majors, and more future scientists and mathematicians might enter the university system."

**Opava:** "Point taken."

**Laura Pickering:** "I'm wondering if building a large portfolio of patents requires a special focus. There aren't many intellectual property [IP] attorneys in San Luis Obispo. Should Cal Poly have its own IP attorney who could help the university grow its portfolio and aid Cal Poly students whose innovations might add to the number of Cal Poly's patents?"

**Opava:** "The IP attorneys that we've engaged don't live in our immediate area. We've found that it isn't difficult to work from a distance with IP lawyers.

"I do believe that at Cal Poly all of us have a strong desire to increase the number of marketable innovations that come from research and development that take place on campus. Our faculty has become increasingly interested in gaining patents. The number of invention disclosures has grown, and many of our faculty are eager to have an innovation licensed and brought to market or to start a company to produce and distribute a patented invention.

"Producing and marketing new products requires a large financial investment. At Cal Poly, we'll always have to balance the amount of money we are willing to invest against what the future profit might be. Decisions concerning investments in patented products must be based on careful, unrushed study, and at Cal Poly we've traditionally taken our time before making large financial commitments to new inventions.

“I do think that if we want the university to develop an income from patents, we’ll have to further invest in infrastructure. For example, Jim Dunning is responsible for the core patent portfolio, and his position is funded by ‘soft money.’ When that money runs out, we’ll have to strongly consider institutionalizing that position, if we’re really interested in expanding the number of patents and gaining future revenues from them.”

**Susan Hackwood:** “What are the academic incentives for faculty to create new products or techniques that might gain patent licenses and become marketable? I know that at research universities R&D projects that receive outside grants or result in successful products are taken into account when a professor comes up for review and a possible promotion in rank. R&D work accounts for approximately one-third of the different elements a committee considers when evaluating the overall performance of a professor. Professors are usually judged on three things: research, teaching and service. Evaluation of their performance usually divides into those three areas, each bearing an equal weight.”

**Stephen Ciesinski:** “Could you further explain those three aspects of a professor’s work?”

**Hackwood:** “Certainly. At research universities like Stanford and Cal Tech, when faculty applicants are considered or existing faculty members are evaluated for promotion or tenure, the committee on academic personnel makes its decision based on performance in research, teaching and service.

“In the area of research, the committee looks at the dollar amounts in grants your work has attracted. That monetary figure is an important element in its decision. As I said, success in research accounts for at least a third of the different factors the committee evaluates.

“The CSU system functions differently. I would ask how Cal Poly can shape its promotion and tenure evaluation procedures to give proper weight to creative activity that takes place outside the sphere of classroom instruction and other academic, non-research activities.”

**Opava:** “Let me begin to answer your question by reassuring our audience that Cal Poly has no desire to become a research-intensive university. I believe that sometimes people become nervous when we talk about increasing research and attracting more funding for the university through sponsored projects. Let me assure everyone that we at Cal Poly have no aspirations to make the university into something different from what it presently is and has traditionally been.

“I know that our president and our provost will support me in the assertion that Cal Poly will continue to abide by its time-proven mission and its learn-by-doing philosophy with its concentration on undergraduate instruction. We are committed to preserving everything that is good about Cal Poly, focusing on our teacher-scholar model that is at the core of our strategic planning and our Western Association of Schools and Colleges [WASC] accreditation.

“The teacher-scholar model lays out a balance between teaching and research, which allows our

undergraduates to take part in research pursued by faculty and is in keeping with the tradition of Cal Poly and its commitment to undergraduate education. As the future unfolds and we further define the university's role in a rapidly changing environment, I think we can continue to say that at Cal Poly research undertaken by faculty will be weighed with the importance of classroom instruction—the time devoted to research and to teaching will be carefully apportioned.

***"We can continue to say that at Cal Poly the time devoted to research and to teaching will be carefully apportioned." – Susan Opava***

"It is true that within the CSU system we certainly have problems with the heavy teaching loads faculty must carry. One of the ways that we can make more time for faculty research is through gaining external funding to hire more lecturers to handle introductory classes, which allows faculty more hours to devote to their own research projects. The hiring of non-tenured lecturers permits us to expand our faculty, and our lecturers are very adept and become nearly indistinguishable from full-time faculty. Lecturers make a great contribution to the university in many ways and are a very valuable teaching asset for Cal Poly and its students.

"In hiring new faculty, and in the granting of tenure and promotions, the university expresses its strong expectation that original scholarship will be an important part of the professional activities teachers at Cal Poly carry out. We have been reviewing our retention, promotion and tenure evaluating procedures, and certain revisions include criteria that reflect the value we place on innovative work. It is true that across our campus the individual colleges and the departments within the colleges retain the freedom to define their vision of relevant and important scholarship for the faculties in their respective academic disciplines.

***"I've always thought that the Central Coast should take greater advantage of the many benefits Cal Poly has to offer, and the new partnership initiative is a tremendous opportunity to strengthen and diversify our economy."***  
***– James Lokey, President, Community Bank, Rabobank, N.A.***

"I'll end my answer by emphasizing that Cal Poly definitely does have expectations that its faculty will do creative and innovative research, and note that faculty members have been denied tenure because they have not met those expectations of original scholarship. At Cal Poly we also have a very generous formula for sharing revenues from licensed patents—our faculty can benefit financially from their inventions, at a higher rate than at most other universities."

**James Lokey:** "You described a Cal Poly initiative that involves the university working closely with San Luis Obispo County and the city of San Luis Obispo and local businesses to expand our area's economic growth by encouraging the development of innovative new companies that germinate from research that takes place on campus. I've always thought that the Central Coast should take greater advantage of the many benefits a university like Cal Poly has to offer, and this new partnership seems a tremendous opportunity to strengthen and diversify our economy.



My question is: How is this Cal Poly partnership initiative proceeding?”

**Opava:** “I’m going to let Bob Koob respond, because he and Dave Garth, from the chamber of commerce, introduced the initiative.”

**Robert Koob:** “One of the difficulties San Luis Obispo has as a city is figuring out who it is. If you live here, you understand that there are a variety of competing interests and many communities within the greater community, each with its own vision of what the city is and how it should or shouldn’t evolve.

“The first question that I raised when I went before the chamber of commerce was whether its members were interested in encouraging new local businesses and expanding the city’s economy. It seemed logical to suggest that the university might be able to return economic benefits to the city, by working with the chamber and local businesspeople to develop new businesses based on innovative work developed at Cal Poly.

“The response was very good and there is now a strong desire within the chamber of commerce and the city council and among county planners to stimulate the kind of economic development I described. I would say that this enthusiasm and concerted determination to proceed is a breakthrough for San Luis Obispo County. We’re at the beginning stages, but I’m very pleased by the receptive atmosphere that we’ve encountered. We have a group representing the different entities I mentioned that meets once a month and is generating a lot of energy. I can’t guarantee that our efforts will succeed, but I’m very excited at the progress I’ve seen so far.”

**Ciesinski:** “I’d like to ask Susan about innovative research that is taking place at other universities that share a similar profile with Cal Poly. There are notable polytechnic schools within the United States, among them Rensselaer Polytechnic Institute [RPI] and Worcester Polytechnic Institute [WPI], where an emphasis is placed on innovation. What are other polytechnics doing to stimulate exciting new research and development that result in licensed patents?”

**Opava:** “I should mention Brigham Young University, although we wouldn’t usually include it among polytechnic schools. Brigham Young has one of the most active tech-transfer programs of all American universities, which is somewhat surprising if you consider its size and its general mission. The university decided to invest heavily in R&D and has developed one of the largest patent portfolios—the university is making a profit from its patents, receiving more money in licensing income than it is spending on its efforts in research.

“I’m interested in aspects of Brigham Young’s approach and know that Lou Tornatzky, who works in the Cal Poly Center on Entrepreneurship and Innovation, has a close colleague at that university who might be able to describe the key points that have allowed Brigham Young to successfully stimulate innovative research and build such a wide patent portfolio.



“As I may have mentioned earlier, Cal Poly until recently had signed only one licensing agreement and that was many years ago. It was a joint agreement with a university on the East Coast.

“Cal Poly’s licensing agreement for the oral airway device—and the polymers it is made of—is the first licensing we’ve done since that earlier effort. At present, Cal Poly receives no licensing income. In terms of the portfolio, which Jim Dunning handles, we have five or six patents. Is that right, Jim?”

***“Cal Poly has a wonderful track record in doing well at what it sets out to do, but many of our very real, important achievements are not widely enough known among the general public.” – Baker Forum Attendee***

**James Dunning:** “We have six or seven patents generated through work done at Cal Poly, and others have been donated from large corporate tech-transfer offices, so that we now have 12 total active patents.”

**Opava:** “We’ve only been trying to develop a patent portfolio for six or seven years and we’re beginning to see a growing awareness among the faculty that our office, which handles patent matters, can be an important resource. Faculty members who have ideas can come in and talk to us about their research and the inventions they’re developing. Again, building a portfolio has not been a central focus at Cal Poly and much work remains to be done if the university wishes to receive substantial income from campus research.”

**Baker Forum Attendee:** “I’d like to emphasize that while Cal Poly is not a research institute, building a more robust IP portfolio is one way to buttress its reputation as a great institution. In reality, Cal Poly isn’t ‘research-based,’ but rather ‘learning- and doing-based.’ The university has a wonderful track record in doing well at what it sets out to do, but many of our very real, important achievements are not widely enough known among the general public.”

**Ciesinski:** “Your point is well taken, and I do hope that in our Panel and Breakout sessions we can address the fact that licensing agreements and revenue streams could over time be quite lucrative for the university, particularly as we face a future that is very problematic in terms of gaining state funding to support all that we want to do at Cal Poly. Streams of revenue from inventions that are co-created with companies for the marketplace could be a valuable addition to the private support Cal Poly receives directly from industry.”

**Hackwood:** “I would like to voice a word of caution about expectations of receiving a revenue stream as the result of a patented invention. Income will depend on the ready and wide demand for the innovation that you’re licensing for manufacture and distribution. I think that if you look at the research universities, at those institutions that actively seek to gain patents and licensing agreements to create revenue streams, you’ll find that their efforts sometimes strike gold but most of the time do not.

“I don’t think that expecting a lucrative revenue stream to result directly from innovative research is a good ultimate goal and it can be an illusion, but it is reasonable to anticipate that creating fascinating new inventions will generate positive publicity and capture the imagination of the public. Our organization a few years ago did a series of reports on the expectations that surround intellectual property developed at universities. At Stanford, for example, the revenue from patents and licensing is not seen as an immediate, direct source of major income, but as a delayed, ‘indirect’ profit that Stanford receives over time, from alumni who have created their own companies and then reinvested in the university.”

***“I can say that the people we seek for work at SRI have acquired many of the same talents developed in Cal Poly undergraduates.”***

***– Walter Moos, Vice President, Biosciences Division, SRI International***

**William Swanson:** “I’d like to make a comment on stimulating research work with the goal of gaining patents and licensing agreements. If Cal Poly is seriously considering ways to expand its patent portfolio, I think it would be important to study those universities—like the Massachusetts Institute of Technology [MIT]—that excel at both R&D and commercializing their innovations.

“In research, you need many ideas to arrive at a really good one, with a real possibility of achieving a breakthrough in technology and a commercial success. There’s a whole process involved in taking ideas through development to gain patents and to make the right licensing agreements to create a profitable product. The monetary investment is great, and a careful decision-making process is essential. I’ve seen very good universities fail to succeed at commercializing the results of innovative R&D. There are many engineers who have a ‘good idea’ every day, but not every good idea makes a successful commercial product.”

**Ciesinski:** “Walter Moos, could I ask you how some of the not-for-profit institutes structure the process of developing innovative research into profitable products?”

**Walter Moos:** “As a preface to my answer, let me describe the qualities that I think a successful SRI employee possesses.

“I can say that the people we seek for work at SRI have acquired many of the same talents that you develop in your undergraduates here at Cal Poly. You’re giving weight to the importance of innovative research, while matching that concern with your learn-by-doing approach that focuses on graduating students with practical experience—graduates who can confront new problems with confidence in their ability to exercise ingenuity and problem-solving, goal-oriented strategies.

“The success of the programs that you have put in place at Cal Poly is most vividly and importantly reflected in the success of your graduates. Perhaps that’s your central venture, preparing your students to succeed beyond the university, and the venture that may return the greatest dividends for both Cal Poly and society.

“I think being successful in research and development depends largely on how you learn and work and how you think when you approach a new problem or challenge. Future shock and creative destruction [*see Keynote address*] require that successful people be fearless about going into new territory. Once they arrive in unexplored areas they need to be very quick studies. Of course they require the appropriate grounding in their particular field, but it is less important for them to know a series of facts than to understand how to dissect a problem and solve it.

“For success, a spirit of resourcefulness is critical, just as a sense of ethics is indispensable. Ends don’t always justify the means, and some people can get carried away, thinking, ‘I’m going to get this done, no matter what it takes.’ Darwin is relevant in this context—many people miss Darwin’s central point, that it’s not the strongest who survive but the most adaptable. In our human world, the ‘fittest’ are typically not the strongest or most forceful or ruthless, but those who are able to meet new challenges with flexible, practical creativity grounded in an ethical sense of what’s acceptable and what isn’t.

“There’s another element that successful students and researchers have in common, and it can be traced to the relationships they’ve had with faculty, at the universities where future scientists are educated. I think that successful students and professional researchers usually have what you could call ‘mentor-derived success traits.’ Somewhere along the line, they have been associated with a faculty member who has been successful in his or her field, and something has ‘rubbed off.’ You’re never quite sure what exactly has been passed on, but you sense that it comes from a teacher and researcher that they have worked with—someone who has been successful time and time again and from whom students have learned a special way of thinking about things, of approaching a problem for the first time.

“Let me return now to R&D and developing profitable inventions for the marketplace. There are places that invest great amounts of money to discover and develop a needed breakthrough innovation, but I don’t think throwing large investments at a problem is the best course. I think the secret is to ‘under-fund,’ to ‘under-staff,’ so that researchers are required to innovate, to use their ingenuity skills to compete with larger programs. If you don’t have a huge research base, you may actually have the right environment for creativity and innovation, because researchers have to strive and be very inventive to be successful. You can see this strategy playing out every day in the world of biotech and at nonprofit organizations, where perhaps a group of 200 researchers in a biosciences division is in competition with thousands of people at a Pfizer or at Merck.

“At SRI, we may have one or two researchers working on an important problem, while at a large drug company there may be 50 people in a program who are working to solve the same problem. You have to be creative or otherwise you just can’t compete. Successful nonprofit organizations invest small amounts of money on a specific program and trust in the spirit of discovery and innovation as the incentive that leads small groups of researchers to find the right answers and to compete with scientists in large companies. Nonprofits have limited funds and you have to steer that money to support experienced people keen on exploring new ideas and approaches.

“Finally, there’s another element in the process of successful R&D and delivering an innovation to the marketplace. People in an organization need to speak a clear, common language, so that they effectively communicate with one another at every step of the process. At SRI, our language is based in the five disciplines for innovation, which I listed in my presentation. Your words have to be straightforward and easily understood when you explain how you plan to dissect a problem. For us at SRI, our foundation in communicating is the ‘NABC,’ an acronym for ‘the compelling need,’ ‘the approach,’ ‘the benefits’ and ‘the competition or alternatives.’ If members of an organization have this sequence of touchstones in mind—whenever they’re thinking and speaking about a problem and how to solve it—then communication is effective and goal-oriented.”

***“The concerted effort of faculty role models is vital in creating a university environment in which inventiveness and innovation are encouraged and prized and become indispensable skills for all our students.”***

***– Susan Opava***

**Opava:** “I really like your phrase, ‘mentor-derived success traits.’ That’s a resonant statement of what I think all of us at Cal Poly believe: that our faculty are role models and mentors for our students, and that successful mentoring requires a dedicated and talented faculty eager for the success of those they teach. The concerted effort of faculty role models is vital in creating a university environment in which inventiveness and innovation are encouraged and prized and become indispensable skills for all our students.”

**Ciesinski:** “I want to thank Bob Koob and Susan Opava for their presentations, and our audience for the interesting and relevant questions. We’ll now move to the next portion of this year’s Baker Forum on innovation, which will be a Panel discussion.”



## **PANEL ON INNOVATION**

**Paul R. Bonderson, Jr., President  
Lone Oak Ventures, LLC**

**Carson C. Chen, Co-Founder and President  
Innovation Quest**

**Keith R. Fox, Chief Executive Officer  
Keith and Pamela Fox Family Foundation  
Investor, Alternative Energy**

Stephen Ciesinski introduced and welcomed the three Panelists for the 2010 Baker Forum Panel discussion on innovation: Paul Bonderson, president of Lone Oak Ventures; Carson Chen, co-founder and president of Innovation Quest; and Keith Fox, CEO of the Keith and Pamela Fox Family Foundation.

***“Our Panelists have an extraordinary record of accomplishment in industry and education, leading successful, innovative efforts within their professional fields while taking a special interest in how Cal Poly can further develop and strengthen its support for innovation.” – Stephen Ciesinski, Chairman, Cal Poly President’s Cabinet***

“Our Panelists all have an extraordinary record of accomplishment in both industry and education,” Ciesinski told the Baker Forum audience. “Each has led successful, innovative efforts within his professional field, and each has taken a special interest in how Cal Poly can further develop and strengthen its support for innovation.”

Ciesinski asked that Panelists and audience agree on a narrowed definition of innovation, to tightly focus their discussion:

“For our questions and comments, let’s define ‘innovation’ as a three-part process: the creation of a product or service that possesses ‘new customer value’; its successful delivery to the marketplace; and the functioning of a sustainable business model for producing and distributing the innovation.

“In our discussion, our immediate purpose is to gain specific guidance from our Panelists, who have achieved success in industry through the practice of innovation. We are eager for their insights into how Cal Poly can best stimulate innovative habits of thought among its future graduates, promote applied research responsive to the needs of California’s economy, and more broadly support a spirit of innovation in our state and nation.”

Ciesinski began the discussion by asking the Panelists the first question:

**Ciesinski:** “What are some of the characteristics of an organization’s culture that either encourage or discourage innovation? And what similar characteristics would we find if Cal Poly’s efforts to promote innovation were analyzed? What would be the university’s strengths and weaknesses, as well as its opportunities to make improvements or avoid potential pitfalls?”

**Paul Bonderson:** “First, there is a tremendous amount of creativity at Cal Poly—I like what Susan Opava said earlier, when she defined ‘ingenuity’ as ‘the quality of being cleverly inventive or resourceful.’ There is a wealth of ingenuity at the university, and during my frequent visits I observe the student projects under way at the project center. The students working there don’t seem to know the meaning of ‘no’ or ‘can’t’ or that those words even exist in our language as they pursue the unfolding of their ideas and research. And their professors are very forward looking. I think Cal Poly has a very ‘open’ environment that encourages both students and faculty to be innovative.

“In her presentation during the Overview portion of the forum, Susan described a number of important programs that are already in existence. Number one on my list of programs that inspire ingenuity are the student projects, which are prime examples of Cal Poly’s learn-by-doing approach in action and show the successful results of that philosophy of education. Susan mentioned the team competition projects, like the super-mileage cars and the solar house. Those activities are marvelous and really do develop both an ability to innovate and an understanding of the importance of innovation.

“At Cal Poly, I sense a tremendous ‘can do’ attitude and the persistence required to carry a project through to completion. It’s a spirit exemplified by Phil Bailey, head of the College of Science and Mathematics, in his patient and successful effort to build the Center for Excellence in Science and Mathematics Education. That persistence, and that belief that goals can be achieved, are attitudes that are transferred to students. I don’t know exactly how those attitudes are passed on, but they are. I suppose you could use Walter Moos’ phrase, which Susan Opava highlighted for special emphasis: ‘mentored-derived success traits.’ Those are important attributes of an organization where innovation flourishes.”

**Ciesinski:** “Carson, could you comment on the characteristics of a culture that encourages innovation?”

**Carson Chen:** “At Cal Poly, those attributes that produce innovation start with the learn-by-doing philosophy and reach to the senior project which every student must complete before graduation. In the university’s core structure, in its approach to practical learning that culminates in the senior project, you have the DNA for innovation.

“There are other institutions that focus on intensive research, and spend great amounts of money in pursuing large projects that are intended to create breakthroughs in basic science. Cal Poly is not one of those universities, but something different and important.

“Among students and faculty at Cal Poly there seems to be an innate ability to pursue the practical, goal-oriented approach, to tell one’s self, ‘There’s a problem in front of me and I need to solve it.’ When a solution is found, the next step in the process is determining whether the solution has a wider application and may be commercially viable.

***“If Cal Poly students view senior projects as a crucible that can produce practical, important ideas, then a self-perpetuating ‘machine of ideas’ should continue to produce impressive results for industry.”***  
***– Carson Chen, Co-Founder and President, Innovation Quest***

“If Cal Poly students view senior projects as a crucible from which practical, important ideas can come forth—rather than just a requirement for graduation—then across the campus you’ll have many ideas bubbling up. If those ideas can be harnessed, and a conduit to industry can be created, then a self-perpetuating ‘machine of ideas’ at Cal Poly should continue to produce impressive results, especially when you remember that there are about 4,000 senior projects every year.”

**Ciesinski:** “Would you comment, Keith, on the elements that encourage or discourage innovation within businesses or universities?”

**Keith Fox:** “I think I’ll focus on possible pitfalls, on things to watch out for and to avoid. In organizations that don’t understand the product they’re delivering, the functioning of staff can sometimes stand in the way of success. I would encourage every member of our audience to consider—from a human resources and organizational perspective—a familiar phenomenon, what I call ‘the balance of powers’ within organizations.

“Having worked at Apple and at Cisco and having started my own company, I’m somewhat of a libertarian: I always challenge large groups and large organizations, if I believe that an organization or a group within it has become too large or too powerful. The swollen size of an operation and the consolidation of power within internal groups can stifle creativity and unnecessarily prolong the time it takes for a product to reach the market.

“The warning signs I look for include any one group accruing too much power within the company. I watch to make sure that the work that’s being done is clearly focused on the targeted goal, and that reaching that goal is the prime objective of those staff functions that support the line functions.

“In terms of encouraging innovation at Cal Poly, you might ask if the staff functions of our faculty—in their role as mentors to help students gain the necessary knowledge and practical experience for career success—are operating efficiently, at full capacity. In business, the one-directional flow of energy toward a single goal creates both innovation and long-term achievement and is a vital element that we’re constantly monitoring.”



**Ciesinski:** “From the characteristics of innovative organizations, let’s move to the attributes of those innovative individuals who are most effective in providing leadership in research, discovery, invention, development, commercialization, or in other areas of marketing and support.”

***“I would say that the No. 1 attribute needed for innovation is passion. If you’re not deeply passionate about what you’re doing, you’re not going to be successful.” – Paul Bonderson, President, Lone Oak Ventures, LLC***

**Fox:** “I look for people who have self-confidence and an understanding of their academic discipline, and who feel at ease in delegating responsibility to the people who work for them. The next important attribute is the ability to motivate others. Can you excite team members about reaching the goal at hand, and channel that excitement into an openness to new learning and new approaches that may be necessary to reach that goal? Finally, I believe that successful leaders understand the importance of results. I seek employees who are results-oriented.”

**Bonderson:** “I would say that the No. 1 attribute needed for innovation is passion. If you’re not deeply passionate about what you’re doing, you’re not going to be successful. In hiring, I always looked for employees who I thought had passion and the ability to persist. Again, let me mention Phil Bailey, who worked each day for 15 years to create Cal Poly’s science and mathematics center. If you don’t have that type of passion for reaching a desired goal, you’ll have a very, very difficult time being innovative.”

**Chen:** “I’d like to share a brief Cal Poly story of a student’s passion and persistence, which has a happy ending. Susan Opava has mentioned the water purifying system—the Polytech Waterbag—that has just been awarded a patent. In 2007, this purifier won first place in our Innovation Quest competition. Again, the system is ingeniously simple—a zip-lock bag contains a chemical that will cleanse gallons of water. The whole kit can be air dropped into remote or devastated areas where people need clean, safe water for their survival.

“Now, after winning the 2007 prize, the Cal Poly students who devised the water purifying kit made no further effort to gain public notice for their invention, except for entering another contest and winning another award for their innovation. The student team then approached me and asked, ‘How can you help us?’ My answer was, ‘Well, you’ll first have to help yourselves. Winning a contest is one thing, but if you want to get into the commercial market and compete, you’ve got to start ‘pumping.’

“After that meeting, the team members on the project graduated or went on to other projects and interests. But one of the innovators—Tricia Compas—stayed with the water purifier project. Trish is graduating from Cal Poly this year and recently I got a phone call from her advisor, whom I don’t mean to criticize—again, the point of this story is the importance of personal passion and persistence, and a shift in perspective that we need to make when viewing innovations and the people who create them.

“Trish’s advisor said, ‘We’re thinking of giving Trish the rights to the purifying system, but there are companies that are interested in it. Shouldn’t we give the rights to a big company, rather than to Trish?’

“My response was that too many people believe that someone can make the innovation and then pass on the rights to market the innovation as a matter of course. Trish had done the work and deserved the right to try to market the invention. She had already won a national inventing prize, the Clinton Global Initiative University award.

“The happy ending is that Trish has gained the right to commercialize her invention and recently signed a contract with the Navy and Marine Corps, who will test the device in field trials. Trish has the drive, the fortitude, the focus, and the excitement and passion to make her water purifier succeed in the marketplace. That’s what we need to invest in—not the innovations, but the people who create the innovations and believe in their importance and commercial value.”

**Bonderson:** “I was going to mention that at my company we use the word ‘champion’ to describe the efforts of people who passionately believe in their creations and ultimately deliver them to the marketplace.”

***“A company’s ability to change quickly is often vital if needed innovations are going to be created and the company is going to remain competitive.”***  
***– Keith Fox, Keith and Pamela Fox Family Foundation / Investor, Alternative Energy***

**Fox:** “I want to mention what I believe is an important aspect of the innovation process. Throughout my career in industry, I’ve been impressed by the fact that a company’s ability to change, and to change quickly, is often vital if needed innovations are going to be created and the company is going to remain competitive. Consistency over time may be a positive attribute for a university, but it’s also true that within the university environment making significant changes involves a very difficult and slow process. Tradition must be balanced against change, but slowness in making needed adaptations to new circumstances can impede innovation.

“Within a successful company, there’s usually a strategic decision to focus on continuous improvement and to continuously look at not only processes but programs, products and services. Constant monitoring and measuring of effectiveness is crucial. But it’s also important to develop what we call ‘radical innovation teams,’ because there are sometimes sudden new innovations or events that radically alter the field of competition. You need to be alert for new offerings in the marketplace that quickly change consumer demand and challenge the effectiveness of companies to meet the new demand and the evolving demands that the innovation will surely create.

“As an example, let’s look for a moment at the iPad, which was just launched by Apple. I believe that the iPad’s emergence will radically change both the personal computer industry and the

definition of the personal computer. Apple has done, and is doing, a terrific job, and their leadership teams deserve much of the credit—they devised a new, radical way to compete in the marketplace, by changing existing rules and expectations.

“I think the iPad example shows that an investment has to be made—in intellectual and strategic emphasis as well as money—in radical innovation teams that can make fast, decisive shifts in direction within the environment of a steady, carefully evolving company.”

**William Swanson:** “I’d like to make a point about teams and their effectiveness. At our company, we insist on diversity in the teams that we create. If I have a team whose members look just like me, I have a good idea of what their answers to a problem are going to be. Teams made up of people of different genders, backgrounds, colors, ethnicities, geographical origins and nationalities provide me with the best answers to the hardest questions. The degree of diversity within a team seems to translate into the degree of insight and innovation of its proposed solutions. The world is becoming a global community, and effective teams are going to have to be diverse if they’re going to discover the global ideas that we need, new ideas that often at first appear ‘radical’ and unexpected.”

**Bonderson:** “In my business we’ve done a lot of innovating, and not all of our new ideas have been successful. Among the lessons I’ve learned from our failures is that the culture of our society and our companies is very ‘mainstream.’ Innovative people tend to be edgier than other employees and tougher to manage. They have an attraction for ‘dumping all the rules’—that’s one of the main reasons that they are original in their thinking. We have to learn to accept the surface difficulties posed by innovators and embrace their different ways of approaching and solving problems. From management and throughout our organizations we need a new mindset in knowing how to effectively encourage creative people and creative thinking.

“We’ve been discussing both individuals and teams, and I think there’s a tendency within companies to look for a champion who can do all things—create the innovative idea, build the efficient organization, quickly understand legal and contractual aspects, hire excellent staff, and neatly fix every problem as it comes up. After a while you pause and begin to realize that there aren’t a thousand Steve Jobses working across the country or within your company. You understand that you need a support team that is also geared towards innovation. One champion can’t handle legal business and IP management, acquisitions, marketing strategies and all the other necessary elements of a successful business that is fueled by innovation. Successful innovations and innovators are supported by a strong, diversified team.”

**Fox:** “The words ‘individual’ and ‘team’ keep coming up. Maybe successful innovations come from understanding your position on the team, from understanding your own strengths and being willing to sometimes differ with other team members.”

**Laura Pickering:** “As many of us have agreed in earlier conversations, an important part of building an effective team is making sure that team members come from different disciplines.

In a team made up of individuals from diverse academic backgrounds, members contribute unique aspects of themselves as well as different perspectives, which makes a team much stronger and balanced. A team can be diverse and still be strong in the specific scientific, technical skills that are needed. Cross-disciplinary knowledge is a vital attribute of successful teams, which join engineering and business expertise.”

*“I’ve been pushing for the multidisciplinary approach at Cal Poly for about 10 years and I think the university has taken important steps in interconnecting different disciplines and departments, although too many isolated ‘silos’ still remain.” – Paul Bonderson*

**Bonderson:** “I agree. I’ve been pushing for the multidisciplinary approach at Cal Poly for about 10 years and I think the university has made progress in interconnecting the different disciplines and the departments within disciplines. Too many isolated ‘silos’ still remain, but I think we’ve taken some important steps—at least within the college of engineering. It’s common now to see mechanical engineers working with electrical engineers and engineers from other areas. That’s a step, but not the big step that we ultimately need. Engineering students need to be working more with the colleges of agriculture and liberal arts and with majors from other colleges. That kind of interaction would create truly multidisciplinary teams. Again, we’ve made progress, but I think we need to concentrate more on bringing the strengths of different disciplines together to form the really diverse, effective teams that can make important innovations and deliver them to the marketplace.”

**Fox:** “I second all of your points. It has been my experience, and I’m sure the experience of many organization managers in our audience, that the work we do for the government or for commercial entities requires multidisciplinary teams who contribute different talents and perspectives, as well as insights gained from life experiences related to background, ethnicity and nationality. Cal Poly needs to move rapidly in encouraging the development of multifaceted teams, if students are going to gain the experience they’ll need in industry, and if industry is going to be supplied with graduates skilled in working as members of diverse teams. I think the need for the kind of teams we’ve been describing will only continue to grow.

“We’re talking about teams and innovation and I want to spotlight Dave Christy from the college of business. Dave and the business faculty have recognized that a business school at a polytechnic university is a different kind of business school from those at other universities. Dave and his colleagues have been making the appropriate changes, especially in adding courses that stress entrepreneurship and a multidisciplinary team approach. I think there was a recognition within the business school of the unusual opportunities as well as the responsibilities that come with being part of a polytechnic university. I would like to see each of our colleges look closely at their missions in terms of Cal Poly’s unique identity. For instance, what special function should the liberal arts assume at Cal Poly and how should majors in those areas be integrated into the wider team—the polytechnic team?”

**Ciesinski:** “I’d like to ask Dave Christy to speak about the increased emphasis on entrepreneurship at the Orfalea College of Business and about some of the changes in direction that Jon York has accomplished.”

***“Our proposal for the University Center for Entrepreneurship and Innovation outlined our plan to create a universitywide asset: a center where everyone could take part.” – David Christy, Dean, Orfalea College of Business, Cal Poly***

**David Christy:** “We were anxious to find talented, unusual individuals who knew how to function effectively as university faculty members and also how to promote entrepreneurship. That’s an unusual mix of backgrounds, but Jon York has that combination of experience and expertise. Jon has a Ph.D., but he has also been a manager in industry and has worked for for-profit and nonprofit organizations. He’s been the president of a midsize city’s chamber of commerce and he has been an entrepreneur and a venture capitalist. It’s great to get all those attributes in somebody so young and energetic as Jon, and he was the right person to help us reach out to the entire university.

“Our proposal for the University Center for Entrepreneurship and Innovation outlined our plan to create a program that would be a universitywide asset. Our purpose was to be inclusive, to develop a center where everyone could take part—we weren’t interested in just building a model for other colleges to emulate. We wanted to avoid the need for an agricultural entrepreneurship program or a liberal arts entrepreneurship program, by creating a center where everyone from across the university and its disciplines could join together.

“Jon has been one of the key leaders in this effort to reach out to people from all the different colleges. He and his team have involved the Cal Poly community at the grassroots level. When we were going through the senate review of our proposal, some people said, ‘Well, I don’t know if our college is part of your plan.’ Jon was able to say, ‘Here are the names of members of your college who are already interested and involved.’ Jon’s team is developing a series of discussion meetings and lectures and we hope to post transcripts of them in the library, because the library is at the center of campus and is a neutral ground for exchanging ideas.

“I deeply believe that we can succeed in making our center a true university asset, as Carson Chen has done with Innovation Quest. His program focuses on engineering—he’s part of an engineering alumni group that supports the college of engineering—but people with innovative ideas from across the university are welcome to participate in Innovation Quest. In our effort to create our center for entrepreneurship and innovation we’ve had great participation from the colleges of agriculture, engineering, and science and mathematics, as well as from within the college of business, and I’m confident that this support will continue and grow.

“I hope that the center will become an example for other cross-disciplinary, large-scale programs that bind the university together. I know we’ve learned a lot in the process of developing and gaining support for our idea, and that future efforts at joining the different colleges in a concerted

effort that benefits students from all of Cal Poly's academic areas will be easier to accomplish, now that our center has been launched."

***"The key is to create a place where people from different backgrounds can meet and the cross-pollination of ideas can take place. Entrepreneurship and research centers can create that necessary crucible." – Carson Chen***

**Chen:** "I think the key is to create a place where people from different backgrounds can meet and the cross-pollination of ideas can take place. Entrepreneurship and research centers can create that necessary crucible. In our Innovation Quest program we work with contestants, with applications and proposals. We see cross-functional teams that have created impressive business plans that are well designed to support the technological innovation and its commercial possibilities—plans that are sophisticated in setting out means and goals.

"Whatever the specific academic focus of the team or its individual members—and regardless of whether the innovation stems from architecture, engineering or the humanities—contestants in Innovation Quest have a sense of scope, of where they're going and a plan for getting there. They understand the sales aspect, as well as the prime importance of a really innovative yet practical idea or product.

"Again, I think the point of central importance is creating that crucible that brings different people from different backgrounds together in a shared interest in entrepreneurship. Friendships develop, ideas are exchanged and debated and balanced, goals are set and strategies worked out. Strong teams can be formed, with members who have different strengths and assets to contribute to reach the goal of commercial success."

**Bonderson:** "I want to underline that we're making progress in encouraging interdisciplinary teams. I've been one of the judges in the Innovation Quest program since the beginning. In the last two years I've seen greater quality in the contestants' business plans, which reflects the work of teams whose members come from a range of majors. We need more of these cross-functional teams—in the beginning of the Quest program there were very few, if any, truly 'mixed teams,' but now there are more and that's a good sign."

**Marianne Wolf:** "In the college of agriculture we've had some success in breaking down the barriers between the different disciplines. In one senior-project class—led by a professor with a grant with Oklahoma State and the University of Nebraska—students from agricultural engineering and agribusiness are working together to help a company develop new engineering solutions for agriculture.

"I've learned quite a lot about the progress of this interdisciplinary effort, because I teach marketing, and students involved in the senior-project class often ask me questions about commercial sales. This is the third year that we've been collaborating with the other universities and bringing together agribusiness and ag engineering students. The senior project is a really



promising area for cross-disciplinary teams to form and work together. At the college of agriculture we're having success in encouraging and developing joint efforts among students from different majors.

"The college of agriculture's wine and viticulture program requires students to take classes in business, viticulture and winemaking. I'm teaching a class called Branded Wine Marketing, and I have students from each of those majors. The first day I asked every student to identify his or her area of concentration. Then I divided the class into teams with members from each area of study. Their project was to develop a new product that would answer a current unmet need in the wine industry, with the goal of creating a brand that could gain a place in the market.

"It has been really exciting to see these students from different backgrounds work together. The college of agriculture—and especially the wine and vit program—is a good place to encourage this cross-disciplinary approach. It remains important that students learn the basics of their individual field, but once they receive a solid foundation they can work effectively as teams, as successful people do in the commercial world beyond the university."

***"Programs that support hands-on experience and innovation should be expanded. Student competitions where knowledge is harnessed to practical applications are among Cal Poly's greatest attributes."***

***– Keith Fox***

**Ciesinski:** "Marianne, you've given us a great segue to the next question for our Panel: What kinds of educational experiences lead students to become successful innovators?"

**Fox:** "Again, the word I keep hearing is 'team'—cross-functional teams that join engineering and marketing and other disciplines to reach a common goal. Marianne's examples from the college of agriculture and the interdisciplinary teams in the Innovation Quest competition are very encouraging. The ability to work within a team—that was the attribute I looked for when I was hiring new people at Cisco and Apple. In my own company, I wanted employees who could 'hit the ground running,' who could, as they say, 'play well with others.' The university experience of teamwork that develops successful innovation—that's very important for our students, and what their future employers will be looking for."

**Ciesinski:** "In my work I visit many different American universities as well as universities in other countries. In the time I've been at Cal Poly, I've always been very impressed with the creative work that takes place beyond the classroom, within campus clubs, student organizations and project programs that involve not only engineering majors, but students in agriculture and business and other disciplines. Do you consider these 'out-of-class' activities a fundamental strength of Cal Poly and should they be further encouraged and supported as an important part of our students' polytechnic experience?"

**Fox:** "I think the university's traditional learn-by-doing ethic continues to work, and programs



that support hands-on experience and innovation should be supported and expanded. The student competitions where knowledge is harnessed to practical applications are among Cal Poly's greatest attributes. And there's a brand-new source of support for these programs, which is especially important as we face a difficult economic situation and gaining funds for these activities becomes harder. We have the new Baker Fund for Excellence in Project-Based Learning that can help support these student competitions. We need to continue to build that endowment, so that resources are available to underwrite existing activities and develop even more opportunities for student participation in competitions that encourage the learn-by-doing experience and the innovations that Cal Poly's philosophy can produce."

**Ciesinski:** "I'd like to ask President Baker to respond."

**Warren J. Baker:** "The informal organizations within the university, the clubs and other activities that students take part in beyond their regular class work, are a very significant part of the Cal Poly learning environment. I should add that faculty mentors are also intimately involved in many of these clubs and programs where important work is being done and students gain valuable experience for future careers."

"When we take surveys of students and alumni, we ask them to choose those aspects of the Cal Poly experience that most promote learning, and their answers are tabulated with each category of experience given a percentage. We typically find that both current students and graduates believe that half of important learning experiences occur within informal structures outside of the classroom and the curriculum. Their survey responses reflect to some extent the faculty mentorship involved in many of these extracurricular programs. There are faculty advisors who have a special interest in working with students on projects, especially in some of the national competitions where teams are formed, many of them interdisciplinary teams, which of course is a strategy that the university strongly supports."

"Again, after observing these activities over a long span of time, I have to say that these programs would not be so successful if it weren't for the involvement of faculty, who are able to supply needed structure that helps chart a practical path for achieving goals. Perhaps these student activities aren't purely 'informal,' but they seem to work in fostering the project base, and students really do believe that they're gaining important knowledge and valuable experience."

"Our graduates attribute their ability to begin successful careers immediately after leaving Cal Poly to the faculty-mentored projects that aren't part of required class work. Very often we hear from businesses and industries that hire our students, and the response from employers is: Cal Poly graduates are ready to go to work. When we ask graduates what prepares them to immediately begin successful career work, they point to the university's informal organizations where they completed out-of-class projects as part of a team."

**Swanson:** "If you receive a really good university education, that education continues to help you 10 years after graduation, when you're working on projects that as a student you had no

***“A really good university education continues to help you 10 years after graduation, when you’re working on projects that as a student you had no idea would be coming your way.” – William Swanson, Chairman and CEO, Raytheon Company***

idea would be coming your way. When I remember back 38 or 39 years ago, to my student days, I had no conception of the kinds of things we’d be working on today at our company—the projects we’re involved in weren’t even thought of when I was doing class work. That’s why a good engineering background is so important, because it allows you to handle surprising, unforeseen problems and projects that confront you.

“You can work on new, evolving technology without fear—if your mathematics and engineering skills are good, if you know materials, and have a solid general foundation in the basic principles of your field. I think that’s one of the advantages Cal Poly graduates have when they begin working in industry—strong fundamental knowledge as well as hands-on experience. As President Baker points out, employers love Cal Poly graduates because they can go to work immediately, without additional training. They are cross-functional and easily work as members of a team, two important skills that make them stand out from graduates from some other universities.”

**Fox:** “It’s very important that Cal Poly graduates are well-rounded and know how to work as part of a team. But there’s another important aspect of the Cal Poly experience that I want to mention—learning how to win. Innovation Quest and other competitions help students become results-oriented people. In hiring, I always look for that one other ‘edge,’ for university graduates who already have the taste for winning. I really want those individuals who know what it is to win and are eager to keep on winning. I like what Walter Moos said, about handling research at nonprofit organizations: Keep the resources light and decentralized and let people innovate. It’s important that we support competitions like Innovation Quest, which reward the winners and teach the importance of success.”

**Carol Hallett:** “I agree that it’s important to successfully compete and develop an expectation of success, a taste for winning, but I also believe that sometimes losing has lessons to teach. Students can learn that in our economic system we have the opportunity to suffer defeat and then lift ourselves back up, work even harder, and ultimately win. Cal Poly has been uniquely effective at instilling the ethic of successfully reaching target goals, but I want to emphasize that how to overcome initial setbacks is important for every team to learn.

“We’ve been discussing teams, and I’d like to ask if any of us have ever seen a team—or an individual—successfully deliver an innovation to market without beginning with a practical and detailed business plan. Whether the team constructs the plan completely on its own or uses a software program to help design the business plan, the fact is that final success in developing and marketing an invention depends on the plan. The innovation may be the work of a single

individual, but teamwork is needed for commercialization. For example, Steve Jobs worked 12 years in his parents' basement, evolving and perfecting his idea, but ultimately it took a team to bring his idea to the public and assure its success.

"My point is that if we continue to follow our learn-by-doing approach that stresses the importance of hands-on experience and effective teamwork, we can build on our past and present successes and people from the worldwide business community will come in even greater numbers to our campus to recruit Cal Poly graduates. Again, I would emphasize that for our students learning to win is vital, but losing can also be a valuable experience if as team members they learn to overcome obstacles and incorporate the lessons of initial failure into their plans and efforts for ultimate success."

***"The concept of risk is absolutely critical and the acceptance of risk is a fundamental strength of American culture that sets us apart from other countries in the world." – Susan Hackwood, Executive Director, California Council on Science and Technology***

**Baker Forum Attendee:** "You have a significant insight about the lessons gained from not always winning. If people aren't willing to risk failure, then they aren't going to achieve any successes. I think what you're describing is a 'leapfrog' of ideas, how it often takes many 'misses' to develop a winning innovation. I have to say that the people I wanted to hire at my organization weren't always those individuals who had always 'won,' but those candidates who had a hunger for winning, who were willing to try a number of approaches, take risks, and endure several failures before finally succeeding. I wanted people with perseverance who had strong personalities and passion and were willing to try again because they believed in an idea and accepted the fact that there were going to be disappointments on the way to developing a successful product."

**Susan Hackwood:** "The concept of risk is absolutely critical. The acceptance of risk is a fundamental strength of American culture and an attitude that sets us apart from other countries in the world. I've recently been interviewing a number of job applicants for various positions, candidates who hold Ph.D.s. One question we've been asking concerns the 'precautionary principle'—that's the principle or rule that says that you don't create an innovation unless you're absolutely sure that it will do no harm, that it won't damage the environment or cause other bad effects.

"Of course, we all know that if we had always followed that rule to the letter then we wouldn't be driving cars or riding in jets or working at our computers or doing a vast number of things that we consider vital parts of modern life. It was amazing to me how many of these very, very bright and wonderful people with Ph.D.s religiously followed the precautionary principle, which appeared to be their fundamental core value. I'm afraid that mindset isn't the strength of our culture or what makes for successful entrepreneurship. Where did the job candidates I've been interviewing develop the precautionary principle as their basic value? They learned it at Carnegie

Mellon and Harvard and other top universities. I have to say that I think that this risk-adverse attitude—as a guiding principle—is a death knell for creativity and innovative entrepreneurship.”

**Ciesinski:** “Let’s continue talking about culture, but in terms of Cal Poly in particular. How does the university environment encourage innovation, and what new directions might we take to increase creative thinking?”

***“Increasing mentoring hours will depend on endowments and other funding sources to increase faculty time with students outside regular classroom work.” – Keith Fox***

**Chen:** “The most important part of Cal Poly’s culture is its learn-by-doing philosophy. We mentor a lot of student teams that are working on creative projects, and when representatives from business and industry visit campus and observe student products, the message is almost always the same: ‘Never stop dreaming, and never stop experimenting. Experimenting produces insights, and insights produce vision. Vision drives innovation, and innovation creates success in the market.’

“When you have a market success, you can reinvest in R&D and more experimentation and the cycle for success starts all over again. At Cal Poly, students work on and complete a senior project—that’s their first level of experimentation. Sometimes they’ll have success with their initial efforts, but very often they’ll have to make several attempts. Encouraging students to learn the importance of continued experimentation is a key aspect of creating an innovative spirit within the university. Again, I like the word ‘crucible’ and I think Cal Poly is a university where students can formulate and experiment with ideas that can produce important innovations for the marketplace.”

**Fox:** “I spoke earlier about the resistance to change within universities. Sometimes it’s absolutely vital to make certain changes, and to make the right changes at full speed. I believe in applied research and in providing more time for faculty to advise student teams that work on out-of-class projects and enter competitions. I think we need to concentrate on finding ways to create more release time for professors, away from the classroom, so that they can increase their mentoring on student projects that take place within clubs and other extracurricular organizations.

“Again, I realize that Cal Poly is a learning institute and that professors must concentrate on teaching the curriculum, but there has to be a balance between classroom hours and the time spent working with what President Baker calls ‘informal organizations,’ which are very popular among students and encourage teamwork and innovation.

“Increasing mentoring hours for professors will depend on funding, and we have to look toward endowments and other sources of support to allow faculty to spend more time with students outside regular classroom work.”

**Bonderson:** “I would focus on a system of rewards, at all levels within the university. I think a rewards system is worth considering seriously, because people are most likely to do work that they are rewarded for.

“If we want Cal Poly graduates to be successful, to be risk takers who thrive on competition and a desire to win but are also able to learn from and capitalize on their failures, then we need to create rewards that encourage those attributes. Rewards for students might come through setting up more competitions for teams to enter, or other goal-oriented activities that develop those skills that we want our graduates to have.

“We should also find ways to reward faculty members who mentor these student teams. Do we presently have a system to reward faculty who advise on out-of-class student projects? If not, what rewards should advisors win and what kind of a rewards system would best encourage more faculty to mentor student projects?

“And finally, we need to look toward the administration and ask if the university is doing enough in creating an environment where students and faculty can develop innovative projects beyond the requirements of regular academic work.”

**Ciesinski:** “‘Rapid prototyping’ is a term that is currently in fashion. It means sending projects or programs or ideas out into the marketplace even before there’s a business plan. It’s a strategy frequently used by many new start-up companies, but less frequently by large organizations. Is this strategy known and discussed or employed at Cal Poly?”

**Baker Forum Attendee:** “I think every student engineering project that’s done in class at Cal Poly is a rapid prototype—these projects haven’t yet received full engineering or been developed in detail for the marketplace. Rapid prototyping is an important part of classroom assignments.”

**Ciesinski:** “Is rapid prototyping part of the vocabulary in other colleges at Cal Poly?”

**Baker:** “In student projects and in the mainstream engineering curriculum, rapid prototyping has been in place for some time and I’m sure the strategy has spread to other disciplines. I know that the engineering faculty view rapid prototyping as an increasingly interdisciplinary process. Jon Monett has set up a laboratory at Cal Poly and I’d be interested in his response. Jon started a company, developed and sold it, and in his new laboratory innovation and invention are the set goals for success and for the wider goal of improving our society’s quality of life.”

**Jon Monett:** “I’d first like to comment on a previous topic: the importance of taking risks and learning from setbacks. People who are risk averse are not going to accomplish very much. If you take risks and ‘push the envelope,’ you’re going to fail at times. People who have encountered failure, learned from it, and continued developing an idea are the people that you want on your team.

“I’m very familiar with rapid prototyping—I come from a world where ‘quick reaction capability’—QRC—is the way of doing things. At Cal Poly, students have to produce a product in a very short period of time. They have two or three quarters to develop a product, which is rapid prototyping, or QRC. I ran a QRC lab at the agency, and in teaching engineers the QRC process I contrasted two possible ways of thinking as you begin developing a new project. One engineer might ask, ‘What do I need to do this job?’ while another engineer asks, ‘What do I already have to do this job?’

“The second engineer’s approach is the way projects are handled at Cal Poly, and the approach that I stress. The engineers that we hired at our QRC lab all think in terms of applying already available resources to solve problems and create a product. I’m amazed at the innovations and the projects that are coming out of the QRC lab and if I could I would hire everyone who trains there.”

***“In farming you have to be optimistic and enthusiastic and open to new approaches and techniques. Those attitudes are part of the culture at Cal Poly, more than at any other school that I know of.”***

***– Douglas Maddox, RuAnn and Maddox Dairy Farms***

**Douglas Maddox:** “I recently took part in a Cal Poly agricultural seminar and I heard participants praising a farming operation developed by a farmer who was attending our meeting. The conversation concerned ‘the farmer’s great farm,’ and his ‘other great farm over there,’ and ‘the one over there.’

“Finally, I turned to the farmer and asked, ‘How many farms do you have?’ He answered that he had farms in four different states. I then asked him how he had become so successful and he said, ‘It’s all because of Cal Poly.’ ‘When did you graduate?’ I asked, and he said, ‘I didn’t graduate. I was only here a year and a half.’

“My next question was, ‘What did you learn at Cal Poly, in that year and a half, that helped you become such a successful farmer?’

“‘Optimism and enthusiasm are contagious,’ he answered. ‘I learned how to learn while I was here.’

“Especially in farming, you have to be optimistic and enthusiastic and be open to learning new approaches and techniques. Those attitudes are part of the culture at Cal Poly, more than at any other school that I know of.”

**Ciesinski:** “Well said.”

**Thomas Jones:** “At the College of Architecture and Environmental Design we’ve been using rapid prototyping—we use that phrase often in projects involving the built environment. I’d



like to comment on recent developments in industry and how we as educators respond to those changes that are taking place in the profession beyond the university. New trends and techniques offer instructors both a challenge and an opportunity as we prepare our students to practice rapid prototyping.

“In the field of the built environment, there has been a performance- and sustainability-driven demand that we break down the barriers separating the various phases and aspects of construction—between those people who design buildings, those who manufacture materials such as ceiling tiles and steel, and those who do the actual constructing of the buildings. We’re now moving to an integrated system of rapid prototyping, in which designers, fabricators and structural engineers design and digitally drive the machines that stamp and produce the materials. This work is done on demand—materials aren’t produced beforehand and stored in warehouses, and some of the building materials are customized for new, innovative buildings which have special requirements. This integrated process combines the best current knowledge of the manufacturers—who research and develop improved materials—with a building-driven, specific strategy that we call rapid prototyping.

“At our college we are using this process—we’ve just purchased special equipment costing \$90,000, which came from a ‘one-time’ fund. It’s a large investment that we receive every 25 years for new equipment. Because we were able to gain and use this equipment, our college has suddenly emerged as the national leader in rapid prototyping.

“Right now, our students are working on projects around the campus, designing and building physical models. To fabricate necessary materials, they do a full-scale mock-up of a part, and then machines driven by students’ computer-generated digital images cut the plywood. Students then construct the model building. All of this work is done by teams whose members come from different departments. Our goal is to include business and engineering students in these rapid-prototyping projects.

“We have a special lab where we carry out rapid prototyping, and as architects we of course had to give it an interesting name—it’s called the DIFAB lab, an acronym for ‘Digital Fabrication’ lab. The lab’s creation is a result of having innovative faculty who were intensely interested in the idea and the robust tie we maintain with the leaders in our industry—those innovators who are at the forefront of new developments in architecture.

“There’s an important symbiosis between industry and the university—innovations created by faculty and students further industry, just as industry innovations cause university teaching and hands-on projects to evolve in new directions. Our profession needs to do much more in integrating university and industry research and development. As always, new work at the university depends on increased funding. We need more space and fortunately we have a new building under construction now, paid for by funders.

“To continue innovative work at a rapid pace, our college needs \$100,000 or more a year in



additional equipment. Unlike at Carnegie Mellon and some other polytechnic institutions, we at Cal Poly don't have a large technical-purchasing fund with the magnitude that we require to continue to be cutting-edge innovators. At our university, funding is necessarily divided among the different colleges, and that money is limited. The CSU funding model doesn't give us sufficient resources to purchase new equipment that representatives from industry are telling us is necessary if we're going to do work that is creative and relevant to the directions modern architecture is taking.

"Our challenge remains in finding sufficient space to carry on our work and in purchasing needed new equipment, which requires building a polytechnic reinvestment fund for that innovative equipment, so that we can continue to be innovative educators."

***"Cal Poly has been a leader in encouraging projects and activities where different disciplines work together toward innovative goals. The university has been especially creative in finding ways to fund these team efforts—a funding effort that absolutely has to continue." – Susan Hackwood***

**Baker:** "The CSU funding plan that we put in place about 13 years ago, along with college-based fees, provides support that Tom's college depends upon to remain innovative in teaching and in keeping students current with breakthroughs in their field.

"The shortfall in financial support that Tom has described demonstrates the difference between the baseline funding that Cal Poly receives—like all other universities—and the further investment that is needed to cover the actual cost of delivering a cutting-edge program that Tom is committed to providing for his students. How many other American universities are actually striving to supply the missing funding that really innovative programs require? Not hat many.

"We need to continue to push forward in seeking additional support beyond the baseline funding that we receive, and we need to recognize that the plan we put in place needs to go forward or it will be stymied. What I am most concerned about is gaining the support that we need to fund the kinds of project-based learning we've heard about today and that make Cal Poly a truly polytechnic university committed to fostering concerted, interdisciplinary projects and an exchange of innovative ideas."

**Hackwood:** "Warren's point is very important, and relates to previous insights that we've heard, especially to those comments concerning the development of a rewards system within the university, which would support and reward interdisciplinary teams and projects. Cal Poly has been a leader in encouraging projects and activities that involve the different disciplines working together toward innovative goals, and the university has been especially creative in seeking and finding ways to fund these team efforts—a funding effort that absolutely has to continue. The multifaceted approach that calls on the combined skills of students from different academic backgrounds is obviously the way of the future. Developing innovative technologies

and successfully introducing them to the marketplace require the work of teams whose members bring different perspectives to a joint effort.

“As I speak, I’m looking up at the Baker Forum logo. What does that logo say to you? At the top portion of the logo, I see an atom with an electron cloud around it, and to me those figures represent science. Just underneath the atom and the cloud are curved lines that I think are meant to represent a flower.

“Now, to me, those lines look more like the slashes made by the steel claws of Wolverine, the hero of the X-Men movies. Wolverine represents the combination of man and machine, which is the successful integration of the human and the scientific.

“My perception of the logo is an example of how different people can look at the same image and see different things. In effective teams, unique individuals contribute their own vision to define a challenge and help devise ways of reaching a common goal.”

**Ciesinski:** “I can’t think of a better way to close this session and begin our Breakout sessions as the final portion of this year’s Baker Forum. We’ve had a stimulating discussion that I know has been helpful for those of us at Cal Poly and I believe for those of you from industry.

“I want to thank our three Panelists for presenting their views and answering our questions, and our audience for providing interesting commentary.”



## **BREAKOUT SESSIONS**

### **BREAKOUT I: INVENTION**

***Convener:* Paul V. McEnroe, Rancho La Purisima**

***Facilitator:* Jonathan York, Associate Professsor, Entrepreneurship  
Orfalea College of Business  
Cal Poly**

### **BREAKOUT II: DEVELOPMENT**

***Convener:* Richard A. Bergquist, Former Chief Technology Officer /  
Senior Vice President, Technology and Applications  
PeopleSoft, Inc.  
Director, Locus Technologies**

***Facilitator:* Ignatios Vakalis, Chair, Computer Science  
College of Engineering  
Cal Poly**

### **BREAKOUT III: MARKETING**

***Convener:* Keith R. Fox, Chief Executive Officer  
Keith and Pamela Fox Family Foundation  
Investor, Alternative Energy**

***Facilitator:* Marianne M. Wolf, Professor, Agricultural Business  
College of Agriculture, Food and Environmental Sciences  
Cal Poly**

Stephen Ciesinski welcomed the audience to the final portion of the 2010 Baker Forum and then asked Paul McEnroe, Richard Bergquist and Keith Fox to summarize the discussions and conclusions reached in the Breakout sessions they had chaired. The three Breakout sessions each considered one of the subjects of discussion: invention, development and marketing.

\* \* \*

## **INVENTION**

**Paul McEnroe:** “We began our conversation by asking, ‘What is invention?’ A number of definitions were offered that stressed the importance of creative thinking and the actual process of innovation. We discussed the characteristics of inventors, and what Cal Poly can do to encourage those attributes among its students, so that our graduates will be prepared to create successful, needed inventions as they pursue their professional careers.

“Our session agreed that the first objective in stimulating future inventors should build on

Cal Poly's 'learn-by-doing' credo, especially by emphasizing the importance of creativity to entering students just beginning their university studies. The creative impulse should become part of each student's thought process and continue to develop as students concentrate on their chosen majors and work toward graduation. We concurred that Cal Poly's required senior project was a key element in building the innovative approach that all future inventors will require to succeed.

***"The creative impulse should become part of each student's thought process and continue to develop as students concentrate on their chosen majors and work toward graduation." – Paul McEnroe, Rancho La Purisma***

"There was unanimous agreement that creativity should be a hallmark of all the disciplines, and that interdisciplinary experience should be further encouraged. We underlined the importance of multidisciplinary student teams in which students with different preparation and perspectives work together to reach a goal. Inventors need to join with team members who have organizing skills and are able to promote a project and make it successful. Jon York described the Entrepreneur Club he has developed on campus, and our session members agreed that Jon's efforts marked a direction that Cal Poly needs to pursue further.

"Jon pointed out that half of the students in the club come from majors other than business—Jon is in the Orfalea College of Business, but he's involved in an effort to reach across the different disciplines to stimulate interest in entrepreneurialism and encourage all Cal Poly students to gain experience in that part of the invention process that delivers new products to the marketplace.

"Our response to Jon's description of his club for entrepreneurs was that we needed to either 'multiply' Jon or multiply the kind of organization that he's put in place. Of course, like all universities, Cal Poly operates under funding restraints, and many faculty are already overburdened, but Jon's club is an excellent and innovative addition to students' Cal Poly experience, and more organizations like Jon's should be created across campus—the more the better. There are presently about 100 students in the Entrepreneur Club, and Jon would like the club to grow larger, although he acknowledged that increased time and resources would be needed to expand his effort.

"Discussion of Jon's cross-disciplinary club underscored the fact that contemporary students are 'networkers,' as are workers in industry and business. Networking is now the standard strategy for developing innovative ideas on campus and in the professional world. The team approach has replaced the solitary effort—one person working alone—that was standard when many of us were in college. Almost all of our Cal Poly students realize the importance of joining or forming networks, of working across the campus with students from other majors and learning from them, so that students with different aptitudes or areas of interest influence and support one another and widen their range of experience and knowledge.

"We noted that many students within various Cal Poly colleges are winning competitions

with their inventions and entrepreneurial projects. These successful efforts are impressive achievements for the winning student teams, their colleges and the university. Although it's true that about 90 percent of student entries fail to win prizes, our session members acknowledged the potential value of student teams suffering setbacks and disappointment, as initial failure may become a spur to increased effort and ultimate success.

"Session participants were in agreement that we need to do follow-up on Cal Poly graduates who win student competitions, to discover whether they further develop their winning ideas after leaving campus. We felt that the university should know more about the outcome of award-winning student innovations and if these ideas make their way to the marketplace. Our session recommends that Cal Poly increase its contact with alumni to track the evolution and success of innovations that were developed at the university.

***"Sensing which innovations are truly important is a success skill that is valued and being taught and encouraged at Cal Poly."***

***– Paul McEnroe***

"An important point that our session highlighted was the value of recognizing a really good idea when you see it, how sensing which innovations are truly important is in itself a success skill—a talent that is fortunately valued and being taught and encouraged at Cal Poly. Many of our session's participants stressed the importance of developing the critical ability to sense the originality and possibilities of ideas that originate from others.

"Doug Maddox of RuAnn and Maddox Dairy Farms commented that although he wasn't among the people who were creating new inventions, it was part of his work in business to study ideas, proposals and potential programs that come to him—from students and faculty in the University of California system and from California State University schools. Doug agreed that sensing a promising new idea and knowing how to implement it was a valuable skill.

"We may not all be innovators who make the important discovery or find the new approach or application, but many of us can be the ones who grasp the value of an innovation and know how to develop it and present it to the marketplace. At Cal Poly, we need to impress on students the importance of that critical, practical judgment and the ability to know how best to make the innovation a reality.

"In asking ourselves whether at Cal Poly we were doing all that we could to reinforce the creative process, we talked about the many different programs that were in place and were furthering the spirit of ingenuity among our students. Some concern was voiced about the large number of required classes within certain disciplines, and we focused attention on the college of engineering and the intense pressure that college is under to meet requirements set out by the Accreditation Board for Engineering and Technology [ABET].

"Engineering students must take so many required courses that they have little chance to enroll

in entrepreneurial classes or other offerings in business or other fields. Students' time is almost entirely committed to fulfilling coursework in the engineering major, and future engineers can't explore other academic areas unless they make a strenuous effort that might require another year or two at the university. This restriction of academic opportunities that students in engineering and some other majors face is a problem that needs to be addressed if our graduates are going to be well-rounded and reach their full potential in their chosen careers.

"An interesting sub-topic that we considered was the importance of assuming different roles within a team, to be both a leader and a follower, an innovator and someone who further develops or commercializes the innovation. I'd like to very briefly describe a firsthand experience that I had early in my career, which I think illustrates the value of learning to work in different capacities as part of a team.

"In my early days at IBM, many of my colleagues and I chafed at what we thought were the company's 'stupid rules'—rules that I later realized were valuable for gaining important experience and learning to be flexible and innovative.

"At IBM there was a stipulation that you couldn't reach the level of senior executive management unless you had earlier managed every kind of business that was represented within IBM. At first, I must not have been aware of this policy—as a junior member of management I'd see colleagues suddenly demoted and automatically I assumed that they had fallen out of favor with higher-ups.

"I was wrong—young managers transferred to other, 'lesser' duties weren't on their way down but instead gaining experience in order to be promoted. IBM wanted to make sure that their future executives had been involved in every area of the company, from manufacturing to sales to finance. I saw John Akers go through this 'downward promotion' process just before he became president of IBM. He was a senior vice president and suddenly he was 'demoted' to a less important job where he supervised staff personnel. Everyone that I knew assumed that John was 'out of the chain,' and then a few years later he became IBM's CEO.

"The point of my story is that the opportunity to experience different functions within a team is available at Cal Poly, through classroom projects and also in extracurricular clubs and organizations and similar activities beyond the required curriculum. In our session we were impressed that Cal Poly offered students a chance to take different roles while working on team projects and to learn from team members from other disciplines. We agreed that assuming a variety of tasks to help a team reach its goal was another very positive aspect of Cal Poly's emphasis on teamwork.

"In talking about innovation and creativity at Cal Poly, our consensus was that the spirit of ingenuity should be encouraged in every academic discipline on campus. The importance of invention should be stressed in every major and become a valued skill in every area of study, not just in the colleges of engineering or business or architecture. What we really need are

more campuswide innovation and creativity models, as Jon York has developed with his Entrepreneurship Club, which originated in the business college but which he's made available to students from every major across the campus.

"A number of Cal Poly colleges are committed to a cross-disciplinary emphasis on innovation through teamwork. The College of Architecture and Environmental Design has many different programs that contain elements that could be implemented across the campus—I'm thinking of its library, which is open to students in other majors, and its programs that study on-campus problems and use a team approach to find solutions. One example was the designing of a community room—students discussed the pros and cons of different ideas, took a broad-based view of how best to apply their creativity, and then reached agreement and constructed the room.

***"Building a culture of innovation involves exposing students to a wide range of technologies, encouraging them to discover areas of study beyond their academic concentrations, and emphasizing the importance of learning from students from different majors, places and backgrounds." – Paul McEnroe***

"I've already mentioned the need for instilling the importance of creative thinking in our incoming students, so that entering a culture of creativity is one of the first experiences students have when they arrive on campus. A part of building a culture of innovation involves offering students integrated experiences from across the curriculum: by exposing them to a wide range of different technologies; by encouraging them to discover new areas of study beyond their immediate academic concentration; and by emphasizing the importance of learning from students from different majors and valuing the perspectives of individuals from different places and backgrounds.

"These different elements of university culture broaden our students and strengthen and expand the personal and academic foundations from which they view the world. An intensive, detailed knowledge of a chosen field is of course vital, but experiences that widen understanding are positive and encourage an open-mindedness that is a crucial part of creative thinking.

"We did discuss whether the university should offer a cross-disciplinary, integrated course of study. We considered whether specific courses should be designed that incorporate and organize material from different fields in a single class offering. We concluded that presenting students with the opportunity to take classes from across their college's different areas of concentration, and from different departments and colleges, was a better general approach than developing an integrated course of study or individual courses that attempted to bring together the different disciplines.

"However, our session members did remain open to the possibility of developing cross-disciplinary classes that would weave together different areas of study. For example, we agreed it would be a positive innovation if a faculty member in engineering could devise an integrated course that taught a range of skills and approaches to reach practical solutions. Once again, the



immediate obstacle to such courses is the college of engineering's tightly structured curriculum that has to meet the many requirements of the Accreditation Board for Engineering and Technology. Engineering students have very few opportunities to make room in their schedules for valuable but non-required classes.

***“Technology and business are rapidly changing, along with the language used in these fields—students have to incorporate an evolving vocabulary that is both up-to-date and straightforward.” – Paul McEnroe***

“Our session also emphasized the importance of developing a common vocabulary for effective communication across disciplines and technical fields. Effective teamwork that brings new inventions and techniques to the marketplace requires that team members speak clearly to one another and to those beyond the team that they will need to approach and persuade. To succeed, you have to understand and use the language of your technology as well as the language of business. Both technology and business are rapidly changing and that means that the language used in these fields is also changing—students will have to learn and incorporate an evolving vocabulary that is both up-to-date and straightforward.

“Communication is absolutely essential and at Cal Poly we need to promulgate a common vocabulary across the campus. A flexible, clear and wide-ranging language that reflects the changes in technology, in business culture and in our culture at large is a necessity for communicating our ideas and for forming effective teams. A language that is inclusive reflects the importance we place on diversity—the diversity of student projects, academic disciplines, and of individuals and their backgrounds and experiences.

“A common vocabulary not only integrates different ideas and people but also allows diverse members of teams to clearly communicate and understand the many elements involved in presenting innovations to the wider world. The specific vocabularies used in different fields have to effectively flow together into an inclusive language if students are going to give others a detailed understanding of their inventions or new techniques.

“One focus of our discussion on ways to encourage innovation touched on a number of industry practices that are designed to stimulate creativity, and we considered whether any of those strategies could be effectively applied at Cal Poly. We talked about how job candidates were being interviewed and selected by industry, and compared industry's criteria for hiring new employees with Cal Poly's entrance requirements and the priorities that the university sets in choosing among applicants for admission. The skills profile of any university's student body is an interesting subject, especially if the university's goal is to encourage more creativity among all of its students.

“At Cal Poly, we have a student body that is relatively homogenous—students admitted to the university received the highest grades in high school and completed very impressive applications for admittance. The average high-school grade-point average for entering freshmen is over 3.8,

so many new students had 4.0 or 4.0-plus averages.

“Now, one question that our session asked was whether these very highly achieving students were open to risk—which is a crucial part of the creative process—or if they might tend to be risk adverse. We discussed what kinds of admission criteria would promote the selection of the most creative and innovative students who are by definition daring in their thinking.

“It’s very hard to judge written applications, and recommendations from former teachers may not provide a clear reflection of a student’s ability to think in original, innovative ways. And a selection process based on high grade-point averages isn’t foolproof, because we can’t know how stringent the grading standards were.

“We agreed that face-to-face interviews would be a valuable means for determining a student’s potential for creative thinking. Our first inclination was to suggest that all applicants should have personal interviews, but with 40,000 students applying to Cal Poly it was hard to see how an already overtaxed faculty and staff could take on so much additional work.

“One interesting suggestion concerned involving alumni, who might be willing to help in conducting personal interviews. It was noted that this approach is used broadly at Ivy League schools such as Harvard and Yale. Developing an alumni base of interviewers would take time and at first their numbers would be small, but our session felt that the university hadn’t actively pursued the idea of increasing alumni participation in the selection of new students. Graduates of Cal Poly who have entered the professional world could offer valuable judgment in identifying applicants who are creative and unafraid of taking risks to discover and develop new ideas.

“One practical step to better identify innovative applicants would be to add a question on the application form that required students to describe creative projects they had worked on in high school. That information might help Cal Poly choose students who have a special aptitude for invention. President Baker mentioned a young man who was doing absolutely fantastic, original work but couldn’t get into Cal Poly because his grade-point average was only 3.5—he had been spending a large part of his of time working on his special project.

“How do we recognize creative, exceptional persons and make sure that they are admitted to the university? Whether asking for evidence of creative work on the application form would be effective in improving our selection process is uncertain, but we do need to consider ways to identify originality and reward it if we really want to encourage innovation on campus.

“Our central challenge remains to stimulate innovative thinking among students already enrolled at Cal Poly. I remember studying some industry statistics that showed that inventive work was a ‘10/90 program.’ That means that within large engineering organizations 90 percent of successful inventions are created by 10 percent of the company’s employees.

“If we assume that similar percentages hold true at Cal Poly and other universities, then how do

we increase the number of students doing creative work, even while we remember that many people who are not inventors play important roles in making projects successful by working in the development and marketing phases of delivering new products to the public?

“We agreed that extra- and co-curricular activities and co-op programs are quite valuable, and that the university must somehow increase support for these out-of-class team efforts that encourage innovation. We also agreed that success is ‘portable.’ A student who achieves success in one area of study—for example, in electrical engineering—and then does successful work in another area—perhaps by developing an innovative project in architecture or business or agriculture—has gained ‘portability of success.’ These students build a track record of success and an expectation of succeeding at whatever they do.

***“Our Breakout group suggested the advantages of alumni acting in on-campus projects as mentors proficient in their fields who can guide and encourage students.” – Paul McEnroe***

“Programs that stress a broad diversity of experience and encourage versatility help develop students who have the ability and confidence to confront a range of challenges and find practical solutions. Successful, creative individuals have acquired numerous skills and approach new problems with openness and a positive attitude gained from previous successes.

“I reported earlier on our conversation about creating cross-disciplinary, integrated courses of study, and specific courses that incorporated material from different fields. We considered the possibility of developing a required general-education class that focused specifically on the subject of creativity and innovation, and thought such a requirement might have some merit. As part of this dialogue, we discussed joint programs, special minors and ‘mixed programs’ embedded within general electives. We acknowledged that newer programs designed to encourage interdisciplinary diversity might be more effective than some earlier programs that had similar objectives and have slowly been phased out, such as the joint engineering/business master’s program of a few years ago.

“One opportunity for increasing cross-disciplinary experience is already in place—the commons in the library could become a locus point for students to meet, exchange ideas and form diverse teams. The library developed within the college of architecture has also been very successful as a center where students meet and share ideas and experiences and develop a wider perception of their field and its relation to other disciplines.

“Our Breakout group not only liked the idea of alumni helping to interview applicants for Cal Poly, but also suggested the positive advantages of alumni becoming more involved in on-campus student projects, as mentors who are proficient in their fields and can guide and encourage students who will one day join those professions after graduation. Alums could follow the progress of students as they advance through their majors at Cal Poly, offering professional knowledge and experience to help them toward future success.

“Some alumni mentoring is already taking place, and in our session we learned about one alum who is presently mentoring four Cal Poly undergraduates. We think increased mentoring by Cal Poly graduates would be a very positive influence in increasing creative thinking among our students and in encouraging them to be unafraid in pursuing original ideas or approaches that underlie successful invention.

***“So many of the university’s programs that encourage student creativity are faculty driven. Anything that we can do to increase faculty time with students will be crucial in helping our students become innovators.” – Paul McEnroe***

“We decided that mentoring was especially important because of Cal Poly’s location in a relatively small city halfway between Los Angeles and San Francisco. San Luis Obispo is not in Silicon Valley or another R&D center. The university needs to further cultivate its relationships with alums and other professionals who are working a few hours north or south of the Cal Poly campus. We need to increase contact and interaction with people in companies who could act as mentors or provide additional co-op opportunities. We need closer bonds with Cal Poly graduates working in industry, and with those industries themselves, to further develop an on-campus culture of creativity and an eagerness to invent new products for the marketplace—and to increase opportunities for our graduates when they leave the university and seek employment in their chosen professions.

“Our session also felt it was very important to be aware of what other universities are doing, if Cal Poly is going to keep pace with best practices and to continue to evolve as a comprehensive, broad-based polytechnic institution. We need to know what programs and new educational approaches and opportunities other polytechnic schools such as RPI [Rensselaer Polytechnic Institute] and WPI [Worcester Polytechnic Institute] are developing to encourage innovation among their students. Cal Poly should be prepared to take a leadership role among polytechnic universities and institutes and be at the forefront in developing new directions in education to enhance the spirit of ingenuity and innovation. And we need to increase our partnerships with universities in the San Francisco Bay area and in Southern California, as well as with schools in other states.

“One conclusion that we reached in our session may seem obvious but it remains a crucial point to remember. Although Cal Poly has many excellent programs and is developing new ones to address changing conditions within our society and the world of industry and business, the university’s faculty is presently overburdened. As we discussed the importance of the Cal Poly senior project, one participant pointed out that some faculty members are supervising as many as 20 senior projects.

“I want to emphasize that so many of the university’s programs that encourage student creativity are faculty driven. Anything that we can do to increase faculty time with students—by creating new endowments or increasing those already in existence, by developing other sources of funding, or by working with Sacramento to gain more financial support for Cal Poly—will be

crucial in furthering the important programs that help our students become innovators.

“Let me end my summary by noting that our session addressed the concern that Cal Poly’s core emphasis on ‘learn by doing’ may sometimes lead to a kind of ‘conventionality of creativity.’ The sentiment within our Breakout session was quite the opposite: We believe that the synthesis of knowledge and hands-on experience encourages the development of true creativity, and not the kind of thinking that follows well-worn, conventional paths. We agreed that learning by doing was a ‘pusher’ toward innovation and the exploration of new ideas, and not a ‘puller’ toward conventionality and ‘safe,’ outmoded approaches to new challenges.”

**Stephen Ciesinski:** “Thank you for your very comprehensive summary. I see that Mohammad Noori has a question.”

**Mohammad Noori:** “I have a point of clarification. Several times you referred to ABET as a body that imposes very strict and extensive requirements. I’m an ABET evaluator and I have to say that ABET provides very flexible criteria. I would suggest that it might be our faculty’s—especially our engineering faculty’s—interpretation of ABET’s requirements that makes them appear a serious constraint on our students’ time and their ability to take courses outside their special area of concentration.”

**McEnroe:** “If faculty interpretation of ABET requirements is severely limiting our students’ flexibility in choosing courses—especially courses outside the immediate academic focus of their majors—then we must find ways to encourage faculty to be less stringent in their interpretation of ABET guidelines.”

**Noori:** “I’ll work with Provost Koob.”

**Baker Forum Attendee:** “We need to be more flexible in following ABET requirements, especially if we’re committed to breaking down the ‘silos’ that still exist within and between departments and schools. An overly strict interpretation of requirements set out by ABET can make certain academic majors appear as isolated silos, when the faculty’s real motivation is not to separate majors but to carefully prepare students for their professional careers.”

**Noori:** “Especially in terms of course requirements, ABET does not have any specific criteria that dictate how many courses students should take or how many credits they need to accumulate.”

**McEnroe:** “I’m glad to hear that. I’d gained a different impression from other conversations that I’ve had. You should follow through, Mohammad, in working for a less tightly bound curriculum. If the problem is in the perception of ABET and its requirements, then changing that perception is the best way to provide students more freedom in choosing classes that would broaden their experience.”

**Ciesinski:** “We will now hear from Rick Bergquist, who will present a summary on the Breakout session that focused on development as part of the innovation process.”

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## **DEVELOPMENT**

**Richard Bergquist:** “Our session defined ‘development’ as that process that begins when someone takes a ‘brainchild’—often a new idea that’s still a hopeful dream—to a team of people who can develop the potential innovation into a reality and successfully deliver it to the marketplace.

“The inventor needs to clearly convey his or her vision to members of the development team, so that the innovator and the developers all have a clear, single sense of the invention’s possibilities and ramifications and of the end goal that they need to work toward together.

***“Effective development depends on a team’s clear understanding of the inventor’s vision and the team’s ability to quickly adapt to modifications as the original idea takes concrete form.” – Richard Bergquist, Former Chief Technology Officer / Senior Vice President, Technology and Applications Strategy, PeopleSoft, Inc. / Director, Locus Technologies***

“Our group agreed that effective development depends not only on a team’s clear understanding of the inventor’s vision but also on an ability to quickly adapt to possible modifications as the original idea begins to take concrete form. A product evolves as it is readied for the marketplace, just as the marketplace itself is often rapidly changing. Teams developing a new idea are operating in a fluid environment where flexibility and a willingness to make quick adjustments can mean the difference between success and failure.

“A diverse, cross-functional team is a must—today no innovation is developed by single individuals in isolation from others and the wider world. Development teams need to interface with many different people from many different disciplines and backgrounds, with individuals and groups who will have their own ways of perceiving, judging, and valuing a new idea and determining its practical importance. Different people have their own ‘value equations’—successful development teams must be able to persuade not only professionals from a range of other fields but also potential partners or customers from other countries and cultures. Developers increasingly operate in a global economy, where international borders are no longer a barrier to trade and competition, and where communications skills and sensitivity to human diversity are indispensable.

“For development teams to be effective, team leaders have to have the capacity for both creative and critical thought and the ability to choose the right people to be members of the team. Leaders must be able to speak and write clearly and assemble a team that is diverse but skilled at communicating original ideas with clarity. Good leaders select team members who are



independent, creative thinkers and also proficient in different technologies and the vocabularies those technologies use—winning teams operate from a foundation of mutual understanding and coordinate a unified strategy for developing and delivering the innovative product to the marketplace.

“Again, quick adaptability to changing technological and business environments is the hallmark of effective team members and team leaders, who have to ‘hit the ground running’ while maintaining an open-minded inquisitiveness and a flexibility to evolving circumstances.

***“Clear, critical thinking and a willingness to consider unorthodox approaches are skills a leader needs to assemble and direct a successful team.”***

***– Richard Bergquist***

“Our session considered the educational experiences that encourage the development of good team leaders, and we agreed that the style of teaching that they’re exposed to in their university training is very important. Learning ‘how to think’ rather than ‘what to think’ is crucial in building the ability to critically judge each challenge that you confront and to have confidence in your powers of reasoned introspection as you work through a problem.

“Thomas Watson had a motto on a plaque that he kept at his desk: THINK. Just as Watson set the crucial importance of thinking as a benchmark for all IBM employees, we want all Cal Poly students to be able to think through each of the elements of a problem. Team leaders develop and adhere to a vision for success, and their job is finding the best ways of achieving that goal. Sometimes they can use ‘standard practices’ to make an innovative idea a reality, but often they’ll have to find new, creative ways to overcome obstacles and solve important problems. Clear, critical thinking and a willingness to consider different, at times unorthodox, approaches are skills an effective leader needs to assemble and direct a successful team.

“In discussing the Cal Poly curriculum, our session acknowledged that today’s students are being asked to work harder and harder to absorb an increasing range of subjects in greater and greater depth and detail. Every year, industries that will employ future Cal Poly graduates want and expect current students to increase their knowledge and experience. The problem becomes one of capacity—how do students acquire ever-greater amounts of knowledge and at the same time continue to develop the critical skills required to interpret and find practical ways of putting that additional knowledge to use?

“We can quickly find ourselves in a kind of zero-sum situation, where the question becomes, ‘If you want to employ people who have critical thinking skills, what particular parts of an already demanding curriculum are you willing to omit, so that students can develop the ability to confront any new problem and if necessary quickly learn needed technical material on their way to a solution?’

“We’re confronted with a trade-off between the demand that undergraduates master more and

more specific knowledge and simultaneously develop those analytical thinking skills that allow students to successfully approach and resolve new challenges. Our Breakout session decided that the Cal Poly faculty will have to present probing questions to industry to determine the right balance between the mass of new information that industry wants students to learn and the development of those critical and creative thinking abilities that industry insists are necessities for successful innovation.

“Once again, I would emphasize that our session strongly believes that successful development teams clearly communicate and effectively collaborate to reach one set goal as they carry out a variety of different but coordinated, at times rapidly evolving, tasks. Members of a diverse team need to simultaneously understand one another, the innovator whose idea they’re developing and promoting, and the many different individuals in the wider world who work in a changing global economy and must be convinced that the innovation is both important and marketable.

***“Teamwork is a vital preparation for the workplace and a crucial part of the university’s learn-by-doing philosophy.” – Richard Bergquist***

“Clarity of vision, purpose, goal and strategy are based on clear, critical thinking expressed in speech and written language whose meaning is transparent and that all parties can easily and rapidly comprehend. Successful development is the expert honing and presentation of an important new idea so that others agree that the finished idea is as useful and profitable as it is original.

“I’ve described the thinking, organizational and communication skills that team leaders and members must have to work effectively in a very competitive global marketplace that is undergoing constant and increasingly faster evolution. Earlier I mentioned that our session was in unanimous agreement that in this modern business and technological environment it’s the team rather than the lone individual that develops the needed breakthrough for the market. We need to better impress on Cal Poly students the central fact that we’re living in a world where the team and intelligent, creative and coordinated teamwork is the only way to succeed.

“Many entering students aren’t sufficiently aware that they are not going to function successfully only as individuals. Early in their freshman year, they need to be exposed to the reality that they will be learning—and after graduation that they will be working—as members of interdisciplinary teams. As participants on a team comprising those from different academic backgrounds, students may not understand all the detailed and necessary knowledge and experience that their teammates bring to a project, but they should start learning immediately that in today’s world successfully developing new technologies and products requires that innovators’ efforts are directed and coordinated within the team structure.

“Beginning Cal Poly students need an initial awareness and experience of the central importance of the team and of how effective teams work together. As students proceed through their undergraduate careers, they should have more and more involvement and hands-on participation

in team projects. Of course this teamwork experience is a vital preparation for the workplace and is a crucial part of the university's learn-by-doing philosophy, but the early exposure to the team model is the first important step and right now this first component is missing or at least not sufficiently emphasized and developed.

“Another key element in preparing our students to successfully develop new products for the global marketplace involves the nature of innovation and creative thought. I've noted that our session emphasized that future team leaders need to learn ‘how to think’ rather than ‘what to think.’ When we ask our students to be innovative we are asking them to think creatively, and creative thinking can be cultivated and encouraged by the right teaching strategies. A professor can be effective in stimulating a habit of creativity by going beyond lecturing or even demonstrating—by taking a more ‘open-ended’ approach, by asking questions and allowing students the freedom to explore the problem at hand for themselves. We don't want teachers to do the students' learning for them, but instead to help them learn how to learn.

“Now, beyond emphasizing the importance of teams and those teaching skills that help team members develop creative thought, our session agreed that preparing students to become effective developers of innovative products requires that we provide programs and an academic structure that encourage innovation. We do need applied projects and we need industry sponsorships. We know that there have been instances in which companies have become frustrated in trying to involve professors in areas of research and development that those companies were eager to pursue. At the same time, professors have faced frustration because they've failed in gaining industry involvement and support for what they considered important projects. We're aware that the development of industry/university cooperation is sometimes hindered by the quarter system, which places time constraints on completing research and development. Despite these difficulties, however, increasing industry participation within the curriculum is important to our students and deserves continued attention and encouragement.

“Strengthening industry involvement in the courses we offer Cal Poly students—and gaining the advantages of having industry projects become part of our students' academic study and experience—are goals that require continual attention and work. We need to understand that companies are eager to become sponsors for industry-related projects, and that their long-term commitment to developing new products and techniques can provide a valuable continuity to Cal Poly coursework and programs.

“One very important program that offers students firsthand experience in developing both a spirit of innovation and the team approach to problem solving and producing needed products, techniques and services has been in place at Cal Poly for a long time: student enterprise projects. These projects stress the importance of the multidisciplinary team strategy in a real-world context and provide practical, goal-oriented learning opportunities that are indispensable in preparing our future graduates for the complex business and technological environment they will enter on leaving the university.

“We need to continue to promote enterprise projects and increase our efforts to make sure that more students take part in these valuable programs that focus on teamwork and developing entrepreneurial expertise. We would like all Cal Poly students to be involved in at least one enterprise project before graduation, so that this program becomes one of the central experiences of a Cal Poly education.

***“The senior project offers ‘real-life’ opportunities to engage teamwork and multidisciplinary strategies to reach a clearly stated and agreed-upon goal.”***  
***– Richard Bergquist***

“In addressing programs that stress both teamwork and innovation, our session members engaged in a lively discussion concerning the exact nature and purpose of senior projects. Do we want the senior project to be the work of a single individual, who is solely responsible for all facets of the project, so that the student’s skills and capabilities and the value of the work can be accurately determined? Or should senior projects be team projects, and should teams comprise students from the same or different disciplines?

“Obviously, in an ideal world, we would want our students to have a deep knowledge and grounding within their specific field of study, as well as multidisciplinary experience and perspective. Our session was divided on what form the senior project should take, but the majority of us believed that team projects that join different disciplines are the right approach, even as we kept in mind each discipline’s curriculum requirements and the time students must devote to detailed work within their own specific major. The senior project seems to offer ‘real-life’ opportunities to engage teamwork and multidisciplinary strategies to reach a clearly stated and agreed-upon goal.

“We believe it would be beneficial to define the purpose of senior projects in a succinct vision statement that could fit on a pocket card, just as members of a team need to agree on a core goal that is both specific and brief. Our session’s members were all aware of a ‘silo’ orientation to both majors and senior projects, and that this silo effect can be seen running through the different colleges and departments, through their infrastructures, curriculum requirements and budgeting constraints. The nature of senior projects is interwoven with any number of factors already in place, and the present form of these projects reflects the detail and amount of coursework students in a given major are thought to require to begin their professional careers after graduation.

“In talking about the silo effect, some session members voiced general concerns about the rigidity of curricula within individual colleges and departments. Our conversation resembled discussions we’ve just heard concerning the engineering curriculum and ABET. Is the problem of rigidity and a certain insularity within majors caused by suggested or required standards set by national academic oversight bodies? Are department faculties unwilling to alter what they believe are necessary, proven approaches with which they’ve grown comfortable? Is there a tendency for faculty to restrict their teaching to what they already know and avoid changes

that would promote a more interdisciplinary strategy and better reflect the changing world of business and technology beyond the university?

“Again, we believe that we need to agree on a vision statement that clearly sets out what we’re trying to accomplish, that defines the preparation our students require to succeed in the changing world they’ll enter after graduation and how best to provide that necessary education. It is true that our common goal will evolve over time as we consult with industry and business leaders, and that our strategy will have to reflect both the academic standards of the university and its colleges as well as the expectations of our students’ future employers.

***“We need more direct industry involvement in student projects and a more streamlined means for industry and the university to work together for mutual benefit.” – Richard Bergquist***

“I want to re-emphasize the trade-off between providing students with an in-depth knowledge of their academic field and the necessity of encouraging creative thinking skills, that dynamic between what you’ve learned and how you think. The emphasis can’t be just on content, on absorbing detailed knowledge—we have to give at least equal weight to critical thinking and the ability to examine new problems and determine the best way to quickly reach practical solutions by applying the relevant, already acquired knowledge or by quickly learning new information that the problem at hand requires. Our students need to learn to ask themselves, ‘Is there a new, different way to solve this problem? Can I find a better solution by taking a less traditional approach? Have I clearly examined the problem both in detail and as a whole, and will my chosen strategy allow me to reach my clearly formulated goal?’

“I think we need to apply that same kind of problem-solving clarity when we determine the key performance indicators we’re looking for when evaluating our students and the education we provide them. A clear view of our challenges, our agreed-upon goal, and the best means of achieving it will allow us to coordinate our efforts and direct our actions.

“It might be helpful if we remember that we are providing services to ‘customers.’ The companies that will hire our graduates are our customers, just as our students are our customers. We are providing employers with well-educated, creative and energetic employees, and we are providing students with an educational experience that will allow them to become successful in their careers after graduation. Employers want and need excellent employees, and students want to acquire a readily marketable set of skills.

“We need to make sure that our curriculum addresses the needs of both our students and their future employers, and we need to be more knowledgeable about our graduates’ professional experiences, to learn whether the education they’ve received at Cal Poly has fully prepared them to succeed in their careers. We need feedback from industry to know if the instruction that students have received is the right instruction to achieve success. If there are necessary areas of knowledge and experience that we’ve failed to provide, then we have to make changes so future

graduates are better prepared and our curriculum and pedagogy match the demands of employers in a highly competitive job market where technological and economic conditions are always evolving.

“Finally, let me say again that at Cal Poly we need more direct industry involvement, more student projects that involve working with industry, and a more streamlined means for industry and the university to work together for mutual benefit. It is often difficult to implement and develop needed improvements in curriculum, and it’s a challenge to increase opportunities for our students to work on new, real-world technologies and techniques. Improving the educational experience that we provide and working in closer coordination with industry really do depend on personal commitment by individuals determined to make new approaches work.

“We need more faculty and industry mentoring, more on-campus entrepreneurial experience for our students, more multidisciplinary interchange, and more attention to developing and refining important thinking skills that may have been overlooked or underemphasized in a previous curriculum.

“As I list areas where improvements can be made, I want to emphasize that we believe that students graduating from Cal Poly are presently very well equipped with the right set of skills to succeed in their careers. Our observations are not criticisms but suggestions for incremental improvements that will allow future Cal Poly graduates to be even more ready to take their place and excel in their chosen professions. Our session’s message is that Cal Poly is currently earning an ‘A’—our ambition is to increase that already excellent grade to an ‘A-plus.’ Thank you.”

**Stephen Ciesinski:** “That’s terrific, Rick. We’ve now had two great presentations. I’m going to introduce our last Breakout-session leader in a moment, after I call on a member of our audience who wants to respond to Rick’s summary of his session’s discussions.”

**Linda Halisky:** “I am thrilled to hear about the growing awareness of ‘academic silos’ and the consensus that we have to move toward a more interdisciplinary approach. I look forward to increasing numbers of people acknowledging the need for more academic interchange throughout the university.

“But a multidisciplinary commitment to providing a broad educational experience involves more than individual departments collaborating within the college of engineering, or more than interplay between colleges whose curriculum is structured by highly technical science courses. I think that all of our disciplines at Cal Poly need to increase their communication and collaboration with one another. I don’t think we sufficiently realize the contributions that the liberal arts can and do make to a polytechnic education. There are ways in which our distinct disciplines working together can enrich our students, providing a whole range of knowledge and experience and perspective that we need to cultivate and encourage. There are tremendous resources on this campus and we should be taking advantage of every single one of them.”



**Ciesinski:** “Thank you for your insightful comment. We’re now going to hear from Keith Fox, who led the Breakout session on marketing.”

\* \* \*

## **MARKETING**

**Keith Fox:** “I’m going to begin my presentation on our marketing session with a little marketing exercise, by asking everyone in the audience to stand up for a second. Thank you.

“Now, I want you all to say the words, ‘Learn by doing.’ Ready? One, two, three . . .”

**Audience:** “Learn by doing.”

**Fox:** “Again, please. One, two, three . . .”

**Audience:** “Learn by doing.”

**Fox:** “And a third time?”

**Audience:** “Learn by doing!”

**Fox:** “Thank you so much. Please be seated and let me explain.

**“‘Learn by doing’ will remain the cornerstone of the Cal Poly educational experience.” – Keith Fox, Keith and Pamela Fox Family Foundation / Investor, Alternative Energy**

“I’ve recently become aware of an undercurrent of sentiment among people who have long been associated with Cal Poly: They sense and are concerned that there might be a movement to somehow downplay or step back from the university’s traditional learn-by-doing credo and approach. I want to say that Susan Opava’s presentation in the Overview portion of this Baker Forum made it very clear that ‘learn by doing’ is and will remain the cornerstone of the Cal Poly educational experience. That said, let me describe our Breakout session discussions on marketing and the learn-by-doing emphasis our dialogue developed.

“To provide a clear basis for our conversation, we began with definitions, starting of course with the word ‘innovation,’ and then considering the meaning of ‘marketing,’ so that session members shared a clear sense of what marketing is and does.

“We agreed on the basics of marketing, which involve creating a product or service; pricing it; placing it; choosing the right means of distribution; and determining the most effective ways of describing and promoting the product or service to potential customers, who are the target audience of your marketing efforts—by their decision to buy or not to buy, they will determine

whether your marketing campaign has been successful.

“We then defined ‘branding’ and the exact meaning of the word ‘brand.’ We agreed that a brand is, very simply, a promise to the customer of a specific experience that a purchased product or service will deliver.

“From the definition of branding, we moved to the consideration of one particular brand, a brand all of us know very well. The Cal Poly brand has a long history, and is a very strong brand in the marketplace, where business and industry seek the most qualified graduates for new employees and form partnerships with those universities best equipped to further research and development projects. Cal Poly has the brand of a ‘comprehensive polytechnic institution’ with a pedagogy based on learn by doing. Our brand promises employers excellent, proficient, hard-working employees, and promises prospective Cal Poly students a unique, intensive, experience-based education that will develop the skills they need to succeed in a professional career.

***“Our hands-on philosophy fosters many of the elements of innovative thinking.” – Keith Fox***

“The businesses and industries that hire our graduates know what the Cal Poly brand promises and that Cal Poly graduates deliver on that promise. I think that the staff and faculty and everyone associated with Cal Poly should be very proud of the Cal Poly brand, as I know we all are. The points I want to make now are focused on how we can identify areas where incremental improvements in our branding seem to be needed, so that we can make an excellent brand even better.

“In our Breakout session we discussed in depth the Cal Poly brand in relation to the theme of this year’s Baker Forum—we began the conversation with a question: ‘Does the Cal Poly brand mean or imply “innovation”?’ Our session members had a range of responses, based on a variety of perspectives and criteria. Taking part in that dialogue about our brand and innovation prompted me to ask you to join me in the learn-by-doing exercise at the beginning of my presentation. I wanted to emphasize that the bedrock of Cal Poly’s brand promise is learn by doing.

“In earlier presentations at this forum we have heard concerns about existing obstacles to fully promoting the spirit of innovation on campus. There seems to be a consensus that ‘academic silos’ need to be broken down and that our students and faculty need more interdisciplinary interchange and experience if Cal Poly is going to further instill and develop the ability to innovate. Our session members would agree with these suggestions, but my central point is that learn by doing in itself fosters innovation, as well as a number of other valuable skills and attributes closely associated with creativity and ingenuity.

“I’ve explained our learn-by-doing group exercise by saying that I had heard a growing worry that the university was moving away from its learn-by-doing brand. Perhaps our forum’s theme

of innovation suggested to some people that a new general approach was in the offing. I think we need to remember that learn by doing and innovation are closely intertwined with one another. Our hands-on philosophy fosters many of the elements of innovative thinking: It encourages teamwork and the alignment and coordination of team members' specific skills in pursuing a common goal; resourcefulness and the ability to overcome limited material resources, to use 'what you have' to reach a practical solution; and a reliance on the creative impulse and an awareness that taking risks is sometimes a necessity for arriving at new solutions.

"Now, can our students and faculty become more innovative if we add to and strengthen the learn-by-doing experience? The answer is of course 'Yes.'

"Our session members agreed that the university could benefit from a communications and marketing campaign that effectively expresses what unique benefits our learn-by-doing education provides our students and the companies and industries who hire them after their graduation. What elements of the learn-by-doing branding need increased emphasis?

"I think we need to stress that Cal Poly's approach fosters a special relevancy in education—our undergraduates are already 'practicing' their professional careers, engaging through internships and other programs and projects with the real-world marketplace. They are gaining practical experience as they increase their expertise and their confidence in themselves, even as they learn that failure as well as success are part of the world of business and industry. Our students are participating, learning to try different approaches as they begin the work that they will continue after graduation. Our credo of hands-on experience closes the gap between 'knowing' and 'doing,' giving greater depth to academic knowledge while bringing to bear the necessary specifics of intensive coursework to solve practical, concrete problems.

"We began considering what advertising strategies might be the most effective to promote Cal Poly and better market its brand by first discussing how such a campaign should be targeted.

"Should we direct our promotion of Cal Poly to prospective students or to business and industry who will one day hire future graduates?

"Certainly, in a perfect world in which marketing funds were unlimited, we would tell everybody about Cal Poly, about the wonderful way the Cal Poly experience works and the benefits it offers, about the rewards you can confidently expect if you become a Cal Poly student or decide to employ a Cal Poly graduate. Our discussion quickly focused on the fact that the university currently receives about 40,000 annual student applications and enrolls about 10 percent of students who apply for admission.

"It's clear Cal Poly has no problem in attracting students, but we do have some concern—especially given the current downturn in the economy—about ensuring that our graduates find the jobs that they want and deserve. It's true that other universities are physically located nearer large population centers where businesses and industries are based, and that students from urban

universities are receiving a higher percentage of job offers than our students are.

“Because of Cal Poly’s location in San Luis Obispo and the present weak economy, we decided that an investment in communicating and promoting Cal Poly’s unique excellence should be directed toward business and industry, to gain greater levels of employment for our graduates and help attract more project-based collaborations and grants and investments in research and development programs. We think that we should also be placing more emphasis on providing our students with effective career-planning services and sufficient aid and direction toward finding employment after graduation.

***“Business and industry expertise could be very helpful in increasing awareness of Cal Poly’s excellence and its commitment to our learn-by-doing model that prepares many of the nation’s future innovators.” – Keith Fox***

“We should remember that increasing job-placement efforts would benefit our graduates, while at the same time it would help us achieve marketing objectives with business and industry. Successful Cal Poly alumni impress their employers: Alums’ excellent work and their praise for the Cal Poly education they’ve received encourage companies to hire more Cal Poly graduates and to offer support for our university—support which in turn produces more highly educated workers with hands-on-experience who are immediately ready to assume their professional work. You can see that the cycle of mutual benefit for our graduates, their employers and for Cal Poly could be energized by increasing job-placement efforts.

“A good portion of our discussion about how to better ‘market’ Cal Poly—to more effectively promote its many innovative programs, faculty and students and to present Cal Poly’s special identity and purpose to a wider public—focused on the successful public-relations strategies other universities as well as companies use to communicate their uniqueness and distinct missions.

“Cal Poly is fortunate to have many successful business leaders as supporters, some of whom are members of the president’s cabinet, and the PR departments within their organizations could help the university deliver its message and its record of success to the public. We agreed that gaining increased media coverage of Cal Poly’s many innovative projects would be a positive step. The university has limited resources for expanding its outreach and telling its impressive story, but company managers and their PR staffs are experienced in introducing and advancing a brand. Business and industry expertise could be very helpful in increasing public awareness of Cal Poly’s excellence and its commitment to our learn-by-doing model of education that prepares many of the nation’s future innovators.

“Honing the university’s Web site and employing a range of media tools for improved public relations are elements of the different strategies we considered for better publicizing and promoting Cal Poly as a preeminent polytechnic university that through learn by doing emphasizes the importance of new ideas and supports creative thinking that discovers and

develops innovative products for the marketplace.”

**Stephen Ciesinski:** “Thank you for your summary of the marketing session. Are there comments on this phase of innovation?”

**William Swanson:** “I think we need to emphasize the increasing international nature of business and industry. We’re now operating in a global economy and marketplace, and this transformation will only continue to grow and evolve.

“When we consider the future of Cal Poly and its preparation of students who will enter this world economy, we should bear in mind that the campus is not located near a major metropolitan area with large-scale businesses and industries. Most current companies are competing internationally—the university graduates that they hire need an awareness of the global market and those special skills that will allow them to think, work and succeed in an international business environment.

“New employees fresh from the university always have to learn about their new company, but they should already have knowledge of the global nature of modern business and competition. Over the next five to 10 years, I think Cal Poly needs to make a special effort to educate its students in terms of this new reality in which the international aspect of business and industry becomes central to success in the marketplace.”

**Jaime Oaxaca:** “In our Breakout session we talked about the need for increased input from business and industry, about what adjustments and fine-tuning future Cal Poly graduates will need to be successful in a dynamic, rapidly changing competitive environment. New marketplace realities and trends will have an effect across the range of academic disciplines as every area of economic activity continues to evolve.

“Cal Poly alumni who are working at many different companies can be very helpful in providing feedback and guidance to the university and its faculty, and alumni mentoring of students would be especially beneficial in keeping undergraduates up-to-date about emerging directions in business and industry and the set of skills graduates will need to successfully compete in what has become a global economy.”

**Fox:** “‘Diversity’ and ‘globalization’ seem to be key words when we consider the ways Cal Poly needs to prepare students for the new realities of the marketplace. The changing business environment should influence the kinds of interdisciplinary projects students take part in at the university. The learn-by-doing approach will have to increasingly incorporate an awareness that business and industry have become global and that diverse teams are needed to meet the demands of diverse customers and markets around the world.

“Preparing students for this new environment of worldwide competition should become an important part of Cal Poly’s mission. I think this preparation should become a kind of ‘promise’

that the university makes to its incoming students, to its alumni and other supporters, and to businesses and industries that depend on the quality and experience of Cal Poly graduates.”

**Blake Irving:** “What about ‘brand promise’?”

“A brand promise is one of the key elements of successful marketing. Developing a brand promise involves differentiating your service or product from those of other organizations that are promising customers an identical or similar improvement in their lives.

*“In promoting Cal Poly we need to identify those specific attributes that make this university unique.” – Blake Irving, Retired Corporate Vice President, Windows Live Services / Microsoft Corp.*

“In considering the different aspects that support brand promise, and Cal Poly’s brand in particular, I thought of those strengths that set Cal Poly apart from other universities that make a brand promise similar to our own. In promoting Cal Poly we need to identify those specific attributes that make this university unique in comparison to other schools that compete in Cal Poly’s sphere of education.

“Student involvement in faculty research projects, as well as student projects that have faculty advisors but take place outside required classroom work—and the practical, goal-oriented nature of on-campus research—are obvious elements that should be highlighted when presenting Cal Poly’s special identity and value and emphasizing the university’s difference from other institutions.”

**Fox:** “Yes, I agree.”

**Baker Forum Attendee:** “A number of discussions during the forum have been about the need for greater promotion of the university, about better publicizing Cal Poly success stories. Many Cal Poly alumni have achieved notable success in their fields and many of these stories of achievement seem to circulate only among other alumni. I receive *Cal Poly Magazine* and read about Cal Poly graduates from different disciplines who have contributed important innovations within their professions. Their stories are both impressive and interesting. On the Cal Poly Web site the successful work of alumni is often noted, but I don’t get the full ‘flavor’ of their successes or their paths to success that I enjoy when I read the magazine. I do think that the Web site could be improved—you might consider using a ‘Top 20 Success Stories’ header, so that visitors to the site could click on a link and learn about important achievements alumni have made in the professional world.”

**Oaxaca:** “When we consider ways to promote Cal Poly beyond our campus, it is becoming more and more apparent that both Sacramento and Washington, D.C., are prime audiences for a California university’s efforts in public relations. Effective PR work takes account of different groups of potential customers, of their interests and needs and their ways of working and communicating. ‘Pitching’ a brand requires a different approach for different target audiences. Maybe we should carefully select special strategies for gaining the attention of politicians and



people in state and federal bureaucracies who are used to responding to the sophisticated PR efforts of special interests.”

**Fox:** “I would respond that ‘the brand is the brand is the brand,’ that a brand makes certain clear promises that reflect its core identity and delivers on those promises. Although you may be constantly finding ways to improve your product, your brand promise and your basic product remain stable over time.

“It’s true that when half your budget or sales revenues come from government you have to convince politicians of the value of your product, but ultimately success depends on your product’s value and reliability and on the strength of your brand. I do think it would be a good idea to invest more in public relations.”

***“Throughout the Baker Forums, I and many others have appreciated the receptivity of administrators, faculty and students to the informed opinions, suggestions and constructive criticisms of leaders from industry, business and agriculture who have a deep appreciation for Cal Poly and its mission.” – Stephen Ciesinski, Chairman, Cal Poly President’s Cabinet***

**Oaxaca:** “That sounds like a good idea.”

**Ciesinski:** “Thank you again, Keith, for your summary, and thanks to our audience for their informed comments.

“Thank you all very much for that informative discussion on marketing and Cal Poly. It has now come time to close the 2010 Baker Forum and I want to end this year’s forum activities on a positive, optimistic note.

“In the time that this forum series has been in existence, I and many others have appreciated the receptivity that Cal Poly administrators, faculty and students have shown in considering the informed opinions, suggestions and constructive criticisms of leaders from industry, business and agriculture who have a deep appreciation for Cal Poly and its mission. Representatives from the world beyond the university have helped the Cal Poly community see more clearly both Cal Poly’s strengths and those areas where changes need to be made to meet current and future challenges—those rapid changes which are occurring in education, technology, business and in American culture in general.

“This Baker Forum in particular has produced an especially important dialogue and in my estimation is perhaps the best Baker Forum that I have attended. Dr. Walter Moos’ impressive Keynote presentation created the right context for a valuable exchange of varied opinions and experiences about the nature and importance of the innovative spirit. In the Overview, Panel and Breakout portions of the forum, session members expressed a contrast and balance in the range of ideas they engaged. And discussion participants were insightful in addressing the importance of innovation and how to encourage creative thinking on the Cal Poly campus.

“I hope we all read the online report of these Proceedings when it becomes available on the Cal Poly Web site, so that we can further consider the valuable information Baker Forum participants contributed on the significant subject of innovation.

“I want to again thank our Keynote speaker from SRI; our administrators, who presented an Overview of Cal Poly programs aimed at encouraging creativity; our three Panelists and our Breakout-session leaders; and all of you who took part in these important discussions. The sincere interest that everyone showed in listening to a host of opinions was truly impressive and I think reflects well on the culture at Cal Poly that encourages stimulating dialogue and debate within a warm, collegial atmosphere of mutual respect and consideration.

“I want to especially thank Dan Howard-Greene and Kim Uytewaal and the other members of the Cal Poly staff for their excellent work in preparing for this year’s forum and ensuring that everything ran efficiently once the forum began.

“Finally, on behalf of everyone in attendance and on behalf of the entire Cal Poly community, I want to extend our best wishes to President and Mrs. Baker, and once again thank them for all they have done to further the university.”

*(Applause)*

“As you all know, in the next few months President Baker will retire from the presidency of Cal Poly, after leading the university for 31 years. As President Baker prepares to leave Cal Poly, he is still working hard to communicate Cal Poly’s special identity and worth, and is constantly concerned with finding ways to strengthen the university and better serve its students and faculty.

“President Baker’s continuing efforts are a tribute to his belief in Cal Poly and the learn-by-doing philosophy of education that has produced so many distinguished graduates who have made our state, country and world a better place to live. All of us who work at Cal Poly believe we are better people for having had the opportunity to work with President Baker. His personal system of values and the open and respectful manner that he has brought to all of our discussions over the years have been a very positive influence and a model for professional conduct at Cal Poly.

“President Baker, you have left a unique stamp on a unique university and we are grateful for your idealism and your practicality and resourcefulness in leading us to reach worthwhile and ambitious goals. We know that you will always be concerned with Cal Poly’s progress and we look forward to seeing you often on campus and receiving your always wise counsel.

“Thank you, President and Mrs. Baker, and all of this year’s Baker Forum attendees who made this forum a special success.”



## **AFTERWORD**

**Warren J. Baker, President  
Cal Poly**

Cal Poly's 2010 Baker Forum focused on the importance of innovation and was the fifth in a series of biennial forums convened by the Cal Poly President's Cabinet to study and discuss significant policy issues facing polytechnic and science and technology universities. The STEM (science, technology, engineering and mathematics) education pipeline, the future of polytechnic education, and ways in which polytechnic universities might address the issue of sustainability were important subjects that previous forums addressed. I have found the conversations at these forums edifying and inspiring, and in each case cogent presentations and in-depth, wide-ranging discussions have helped set the stage for productive evolution at Cal Poly.

***"The gift of inventiveness must be joined with the hard work of operational development, and a facility for communication and marketing, if a new invention or process is to change the way consumers make choices and form decisions."***  
***– Warren J. Baker, President, Cal Poly***

Past forums have helped inform our strategic planning, stimulated development of new programs such as the Center for Excellence in Science and Mathematics Education, and inspired individual faculty and student initiatives. I am confident the 2010 forum, at which we considered the complex character of innovation and the role of polytechnic universities in encouraging and fostering it, will have similar catalytic effects.

As the 2010 forum Proceedings make clear, innovation is a complex social phenomenon. Typically, no one individual can be credited with conceiving and implementing creative new ideas. It is true that important breakthroughs are in part the result of visionary inventors, capable of looking beyond established thought and practice to arrive at fresh perspectives and approaches. And yet there have been since the beginning of our technological age thousands of promising ideas that were deemed impractical to implement or for other reasons were not widely adopted. The crucial lesson appears to be that the gift of inventiveness must be joined with the hard work of operational development, and a facility for communication and marketing, if the new invention or process is to change the way consumers make choices and form decisions. Only when all three of these vital elements are finely honed and joined—idea, development, presentation—can innovations emerge and successfully take root in society.

At Cal Poly, with our university's programmatic breadth and depth, we have the opportunity to support and advance the cause of innovation in a number of important ways. With our rich mix of applied polytechnic disciplines and strength in the arts, sciences and humanities, our students and faculty can bring to bear on any given problem a range of informed analytical and creative perspectives and approaches. Cal Poly's tradition of project-based, learn-by-doing student educational experiences offers the university the prospect of harnessing the insights and

energies of students and faculty from many fields to tackle discrete applied education and research challenges. And our close engagement with industries and agencies that hire our students and rely on our faculty for applied research support allows us to maintain the relevance of our programs to societal concerns and objectives.

***“Promoting creativity and innovation in practical, meaningful ways is an important aspect of our approach at Cal Poly.” – Warren J. Baker***

Polytechnic universities are, by their very nature, “engines of innovation,” and their faculties, students and alumni have a record of success in fostering and encouraging innovative new products and processes. At the same time, polytechnic universities are more expensive to fund and support than universities that have a more traditional mix of disciplines and pedagogies. Attracting an expert, specialized faculty and technical staff, and developing and maintaining science and engineering laboratories and studios, agricultural farms and research installations, and facilities in support of design and construction fields—as well as many other aspects of polytechnic university infrastructure—require significant ongoing capital and operational investments. The cost of our unique mission at Cal Poly demands unique approaches to budgeting and funding and the development of financial strategies that go beyond what is required by other comprehensive universities.

Cal Poly is engaged in many important but also very ambitious and expensive projects. The University Center for Coastal Marine Sciences, which includes the longest pier on the California coast, supports seawater laboratories and employs remote-sensing robotic submarines. Cal Poly’s agriculture, forestry and biological sciences disciplines maintain 10,000 acres of special field laboratories and observation sites. The College of Engineering, the College of Architecture and Environmental Design, and the College of Agriculture, Food and Environmental Sciences have enrollments that are among the largest in the United States. Cal Poly has been recognized as one of the leading universities in the country for engaging undergraduates in research, and Cal Poly’s unique resources have made our university increasingly competitive in attracting grants and contracts, furthering opportunities to involve even more of our students in applied research before graduation.

The learn-by-doing credo that guides all Cal Poly curricula requires excellent, dedicated faculties and state-of-the-art facilities to support project-based learning which underpins our hands-on philosophy of education. Promoting creativity and innovation in practical, meaningful ways is an important aspect of our approach at Cal Poly. For example, Innovation Quest, a competition established by a Cal Poly alumnus, is held each spring. Panels of professionals review work submitted by students from their senior projects, and cash awards are made to those undergraduates with the most inventive projects and ideas for commercialization. A second screening takes place when plans for employing the awarded funds to further develop the new ideas are presented. Finally, the most promising projects are then assisted by Innovation Quest to acquire additional funding in the venture capital markets.

To fund learn-by-doing education at Cal Poly, we begin with the very important support that California taxpayers provide; strive to expand growing numbers of individual and industry philanthropic sponsors; and continue to engage students and parents as funding partners through the Cal Poly Plan and the campus and college-based academic fees that support it. Without these three sources of funding, Cal Poly would not be able to maintain the quality and national reputation of its programs.

Looking over the horizon, beyond my tenure as president at Cal Poly, I see clearly that polytechnic universities like Cal Poly must give greater attention to expressing their unique educational missions—and related resource requirements—to key constituency and leadership groups. Polytechnic institutions must increase their efforts to communicate effectively and convincingly with students, parents, alumni, trustees, legislators and the general public. While *we* at Cal Poly may be clear about the value that our university delivers to the state and nation—and the significant return on investment our society receives from our programs—we must ensure that the importance of Cal Poly is understood well beyond the borders of our campus.

Meeting this communication challenge will continue to be a central preoccupation of campus leaders, and I am confident the Cal Poly President's Cabinet will remain an invaluable ally in this crucial, ongoing cause.



**2010 BAKER FORUM**  
**EXPLORING THE MULTIPLE DIMENSIONS OF INNOVATION:**  
**IMPLICATIONS FOR POLYTECHNIC UNIVERSITIES**

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